Review of Aging Management Programs: Compendium of Insights from License Renewal Applications and from AMP Effectiveness Audits Conducted to Inform Subsequent License Renewal Guidance Documents

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Technical Letter Report
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ABSTRACT

Title 10 of the Code of Federal Regulations, Part 54 (10 CFR 54), provides rules for renewal of the license of a nuclear power plant (NPP) beyond the initial 40 years for an additional 20 years. However, neither the Atomic Energy Act of 1954 (as amended) nor the subsequent U.S. Nuclear Regulatory Commission (NRC) regulations for renewal include any specific limitations on the number of times a license may be renewed. To ensure its readiness to review possible license renewal applications (LRAs) for NPPs to operate beyond 60 years, the NRC is developing guidance documents for the technical review of applications for subsequent license renewal (SLR), i.e., that would authorize plant operation beyond 60 years. The current guidance documents used for the review of LRAs for operation up to 60 years are the "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" (NUREG-1800) and the Generic Aging Lessons Learned (GALL) Report (NUREG-1801). An important part of this guidance document development activity is the identification of the aging effects for systems, structures, and components (SSCs) within the scope of the license renewal rule that would be important to consider for plant operation beyond 60 years, along with development of aging management programs (AMPs) that will be effective in managing the identified aging effects.

Several of the Argonne National Laboratory (ANL) coauthors were of key importance since the mid-1990s in developing the original and revised license renewal guidance documents (LRGDs). They summarized the technical information and agreements from nuclear management and resources council industry reports addressing license renewal. This preceded the first issuance of GALL in 1996, which they were the key contributors to. Following that time they remained active in reviewing the LRAs, writing requests for additional information (RAIs) and participating in RAI conference calls, drafting input for the safety evaluation reports (SERs), peer reviewing sections of the SERs, participating in audits, and revising LRGDs.

As part of its efforts to develop guidance, the NRC performed "AMP Effectiveness Audits" to provide an understanding of how AMPs have been implemented by NPPs during the period of extended operation (PEO) from 40 to 60 years and the degradation that may have been identified by the licensees in implementing their AMPs. The results from these audits will provide key information to aid the NRC in identifying needed changes to existing AMPs and new AMPs that may be needed to provide assurance of component function for components in the scope of license renewal during an SLR operating period. On a pilot basis, NRC staff, with assistance from ANL, conducted onsite AMP audits for the Robert Emmett Ginna (Ginna), Nine Mile Point Unit 1 (NMP-1), and H. B. Robinson Steam Electric Plant, Unit 2 (HBRSEP or RNP for just HBRSEP Unit 2) NPPs.

This technical letter report (TLR) provides the staff's observations from reviewing license renewal applications for the first license renewal and from the AMP audits. Compared to more than 100 U.S. operating plants the audit effort was limited to three sites at this time. We believe that it is too premature to draw any definitive and generic conclusions as a result of these audits. However, the audits have been helpful for both NRC and industry and have provided early information about AMP implementation, effectiveness, and potential refinements for future such audits. The results of this effort have also enabled the staff to add to its knowledge base and have provided valuable initial preliminary information to consider in developing guidance documents for SLR.

This TLR supplements the content of the earlier TLR “Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna Nuclear Power Plant and Nine Mile Point Nuclear Station, Unit 1 (May 2013, ADAMS ML13122A009).

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EXECUTIVE SUMMARY

Title 10 of the Code of Federal Regulations (10 CFR) Part 54, provides rules for renewal of the license of a nuclear power plant (NPP) beyond the initial 40 years for an additional 20 years. This regulation does not preclude a licensee from requesting approval for an additional operating period beyond the 20-year period of extended operation (PEO), and states, in §54.31(d), that "a renewed license may be subsequently renewed." The U.S. Nuclear Regulatory Commission (NRC) is aware that some licensees are considering submitting applications for a subsequent 20-year (presumably) operating period beyond 60 years. The first of these applications could possibly be submitted as early as 2018. To ensure readiness for review of possible applications for subsequent license renewal (SLR), the NRC is developing guidance documents for the technical review of such applications for SLR (i.e., that would authorize plant operation beyond 60 years). The current guidance documents used for the review of license renewal applications (LRAs) for operation up to 60 years are the "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" (NUREG-1800) and the Generic Aging Lessons Learned (GALL) Report (NUREG-1801). An important part of this guidance document development activity is the identification of aging effects for systems, structures, and components (SSCs) within the scope of the license renewal rule that would be important to consider for plant operation beyond 60 years, along with the development of aging management programs (AMPs) that will be effective in managing the identified aging effects.

To facilitate the development of these guidance documents, the NRC Office of Nuclear Regulatory Research (RES) has been tasked by the NRC Office of Nuclear Reactor Regulation (NRR) with identifying and evaluating aging management of SSCs during an SLR period. Argonne National Laboratory (Argonne) is providing technical support to the NRC staff to develop guidance documents for technical review of applicant submittals for SLR of NPPs beyond 60 years.

As part of its work to support this guidance document development activity, the NRC conducted "AMP Effectiveness Audits" to provide an understanding of how AMPs have been implemented by plants during the PEO and of the degradation that has been identified by the AMPs. The results from these audits will provide key information to aid the NRC in identifying needed changes to existing AMPs and new AMPs that may be needed to provide assurance of safe plant operation during an SLR operating period. The scope of these AMP Effectiveness Audits addressed:

- Understanding how the AMPs have been implemented by licensees during the PEO (e.g., the types of component inspections that have been conducted and any access impediments for the inspections)

- Reviewing the findings from the AMPs in terms of the types of degradation that have been identified

- Identifying how the AMPs have changed based on plant-specific and industry operating experience

In this audit effort the staff conducted AMP effectiveness audits at the Robert Emmett Ginna (Ginna), Nine Mile Point Unit 1 (NMP-1), and H. B. Robinson Steam Electric Plant, Unit 2 (HBRSEP) NPPs for the license renewal period of extended operation (PEO). This TLR provides both insight from ANL's assistance in the review of LRAs for the first license renewal as well as documentation on the staff's observations from audits for mechanical systems, structures, and electrical systems.

The LRA for Ginna was submitted on August 1, 2002, and the renewed license was issued on May 19, 2004, technically supported by the "Safety Evaluation Report Related to the License Renewal of the R. E. Ginna Nuclear Power Plant," issued as NUREG-1786. Ginna entered the PEO beyond 40 years on September 19, 2009. NMP-1 submitted an LRA on May 27, 2004, and the renewed license was issued on October 31, 2006, technically supported by the "Safety Evaluation Report Related to the License Renewal of Nine Mile Point Nuclear Station, Units 1 and 2," issued as NUREG-1900. NMP-1 entered its PEO on August 22, 2009. HBRSEP submitted an LRA on June 17, 2002, and the renewed license was issued on April 19, 2004, technically supported by the "Safety Evaluation Report Related to the License Renewal of H. B. Robinson Steam Electric Plant, Unit 2", issued as NUREG-1785. HBRSEP entered its PEO on July 31, 2010.

Staff from NRR and RES conducted onsite audits during August/September 2011 at Ginna, during November 2011 at NMP-1, and during January 2013 at HBRSEP. The staff reviewed the licensee's implementation of the AMPs and findings from the AMPs, including confirmatory findings of no degradation as well as adverse or unexpected aging effects. Among the areas considered by the staff during its audit activities were the following:

- Inspection accessibility issues, adequacy of inspection methods, and frequency of inspections
- Unanticipated structure and component degradation, related equipment failures, or premature repair/replacement
- Trending information that can yield insights regarding the actual effectiveness of the current AMPs and aging management reviews (AMRs)

The types of information reviewed by the audit team included the following:

- Available results of licensee health reports/assessments of the AMPs
- Sample results from the nonconformance reporting system related to plant aging
- Licensee evaluation of site-specific and industry operating experience
- Changes made to AMP

Any related information about the adequacy of the current AMPs that will assist in the development of guidance for SLR aging management processes and programs

The audits reviewed mechanical system AMPs, structural system AMPs, and electrical system AMPs. In addition, AMPs associated with time-limited aging analyses (TLAAs) were also reviewed, as applicable. The audit process involved onsite interviews of licensee plant

personnel by the staff, with additional participation by telephone by both the staff and, for the mechanical and structural AMPs, Argonne staff.

The license renewal applications for Ginna, NMP-1, and HBRSEP were based on the guidance of Revision 0 of NUREG-1800 (Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants, SRP-LR) and Revision 0 of NUREG-1801 (Generic Aging Lessons Learned (GALL) Report), and the AMPs for these three plants were generally prepared in conformance with this guidance. Accordingly, there is not a precise correlation between the AMPs currently listed in the latest version of the GALL Report, (NUREG-1801, Rev. 2), and those used and audited at Ginna, NMP-1, and HBRSEP. In addition, because Ginna and HBRSEP are pressurized water reactors (PWR) and NMP-1 is a Mark-1 boiling water reactor (BWR), the applicable AMPs are different for the three plants in some cases. The AMPs reviewed at Ginna include six plant-specific programs not contained in NUREG-1801, Rev. 0, three each related to mechanical and electrical systems, and the NMP-1 AMPs include seven plant-specific programs, two each related to mechanical and structural systems, and three to electrical systems. The AMPs reviewed at HBRSEP included three plant-specific programs, three for mechanical systems and one for structural systems.

As well as extensive insights from the ANL participants gained during their role in LRA reviews, this TLR provides the staff's observations from the AMP audits at Ginna, NMP-1, and HBRSEP. Thus, compared to more than 100 U.S. operating plants the audit effort was limited to three. We believe that it is too premature to draw any definitive and generic conclusions as a result of these audits. However, the audits have been helpful for both NRC and industry and have provided early information about AMP implementation, effectiveness, and potential refinements for future such audits. The results of this pilot effort has also enabled the staff to add to its knowledge base and provided valuable initial information to consider in developing guidance documents for SLR.

Prior to issuance of this TLR, the licensee for each plant was provided a summary letter to ensure factual accuracy; significant comments provided by each licensee were incorporated in the TLR. We especially acknowledge the facilitation and review and comments by Michael Fallin, Constellation Energy Nuclear Group, LLC (for Ginna and NMP-1 audits) and by Al Maysam of HBRSEP for the RNP audit.

ACRONYMS AND ABBREVIATIONS

AAI	Applicant Action Item
Act	Atomic Energy Act of 1954, as amended
ACI	American Concrete Institute
AEA	AMP Effectiveness Audit
AERM	aging effects requiring management
AMA	aging management activity
AMP	aging management program
AMR	aging management review
ANSI	American National Standards Institute
AOO	anticipated operational occurrence
Argonne	Argonne National Laboratory
ARC	alternate repair criteria
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
B&W	Babcock and Wilcox
BMV	bare metal visual
BWR	boiling water reactor
BWRVIP	Boiling Water Reactor Vessels and Internals Project
CAP	Corrective Action Program
CASS	cast austenitic stainless steel
CCCW	closed-cycle cooling water
CE	Combustion Engineering
CFR	Code of Federal Regulations
CLB	current licensing basis
CR	Condition Report
CRD	control rod drive
CRDM	control rod drive mechanism
CRDRL	control rod drive return line
CRGT	control rod guide tube
CS	carbon steel
CSB	core support barrel
CUF	cumulative usage factor
CV	containment vessel
DBA	design bases analyses

DEF	delayed ettringite formation
DER	deviation event report
DMIMS	digital metal impact monitoring system
DMW	dissimilar metal weld
DOE	U.S. Department of Energy
DOR	Division of Operating Reactors
dpa	displacements per atom
ECCS	emergency core-cooling system
ECP	electrochemical potential
ECT	eddy current technology
EDG	emergency diesel generator
EFPY	effective full power year
EMDA	expanded materials degradation assessment
EPIX	equipment performance and information exchange
EPRI	Electric Power Research Institute
EPU	extended power uprate
EVT-1	enhanced visual examination
FAC	flow-accelerated corrosion
FERC	Federal Energy Regulation Commission
FME	foreign material exclusion
FMECA	failure mode, effects, and criticality analysis
FP	fire protection
FRN	Federal Register Notice
FSAR	final safety analysis report
FW	feedwater
GALL	Generic Aging Lessons Learned
GDC	general design criteria
GL	Generic Letter
HAZ	heat-affected zone
HBRSEP	H. B. Robinson Steam Electric Plant
HELB	high-energy line break
HPCI	high-pressure cooling injection
HWC	hydrogen water chemistry
IASCC	irradiation-assisted stress corrosion cracking
ICMH	incore-monitoring housing
ID	inside diameter

IGA	intergranular attack
IGSCC	intergranular stress corrosion cracking
IHSI	induction heating stress improvement
ILRT	integrated leak rate testing
IN	Information Notice
INPO	Institute of Nuclear Power Operations
IMI	incore monitoring instrumentation
IR	insulation resistance
ISG	interim staff guidance
ISI	in-service inspection
ISP	Integrated Surveillance Program
LER	Licensee Evident Report
LOCA	loss of coolant accident
LOP	loss of offsite power
LPCI	low-pressure coolant injection
LPM	loose part monitoring
LR	license renewal
LRA	license renewal application
LRGD	license renewal guidance document
LRT	leakage rate test
LTAM	long term asset management
LTO	long-term operation
LTOP	low-temperature overpressure protection
LWR	light water reactor
MEBs	metal-enclosed buses
MDM	Materials Degradation Matrix
MIC	microbiologically influenced corrosion
MMS	mitigation monitoring system
MOV	motor operated valve
MRP	Materials Reliability Program
MRV	minimum required value
MSIP	mechanical stress improvement process
NDE	non-destruction examination
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NMAC	Nuclear Maintenance Applications Center
NMCA	noble metal chemical addition
NMP	Nine Mile Point

NMP-1	Nine Mile Point Unit 1
NMP-2	Nine Mile Point Unit 2
NMPNS	Nine Mile Point Nuclear Station
NNM	neutron noise monitoring
NPP	nuclear power plant
NPS	nominal pipe size
NRC	U.S. Nuclear Regulatory Commission
NSIAC	Nuclear Strategic Issues Advisory Committee
NSSS	nuclear steam supply system
NWC	normal water chemistry
OCCW	open-cycle cooling water
OpE	operating experience
PBD	program basis document
PEO	period of extended operation
PLL	predicted lower limit
PMDA	proactive materials degradation assessment
PT	(dye) penetrant test
PTS	pressurized thermal shock
PWR	pressurized water reactor
PWSCC	primary water stress corrosion
RAB	reactor auxiliary building
RAI	request for additional information
RCPB	reactor coolant pressure boundary
RCS	reactor coolant system
RES	NRC Office of Nuclear Regulatory Research
RG	Regulatory Guide
RHR	residual heat removal
RIS	Regulatory Issue Summary
RLSB	License Renewal and Standardization Branch
RNP	Robinson Nuclear Plant, just HBRSEP Unit 2
RFO	Refueling outage
RO	refueling outage
RPV	reactor pressure vessel
RVI	reactor vessel internals
RWCU	reactor water cleanup
SAW	submerged arc weld
SCC	stress corrosion cracking

SER	safety evaluation report
SG	steam generator
SGMP	Steam Generator Management Program
SGTI	Steam Generator Tube Integrity
SIT	structural integrity test
SLC	standby liquid control
SLR	subsequent license renewal
SLR-GD	subsequent license renewal - guidance document
SRP	standard review plan
SRP-LR	Standard Review Plan for License Renewal
SRV	safety relief valve
SS	stainless steel
SSCs	systems, structures, and components
Staff	NRC staff
STP	standard test procedure
SW	service water
TGSCC	transgranular stress corrosion cracking
TLAA	time-limited aging analysis
TLR	Technical Letter Report
TR	Topical Report
TS	Technical Specifications
TT	thermally treated
UFSAR	Updated Final Safety Analysis Report
UHS	ultimate heat sink
USE	upper shelf energy
UT	ultrasonic testing
WANO	World Association of Nuclear Operators
WOG	Westinghouse Owner’s Group

SECTION 1
Introduction

In accordance with the Atomic Energy Act (Act) of 1954 as amended, U.S. commercial nuclear power plants (NPPs) were granted an initial operating license for a 40-year term that was based in large part on the (projected) period for investment recovery and antitrust considerations and was backed by some engineering analysis and judgment for the minimum safe life of a plant. Title 10 of the *Code of Federal Regulations* (10 CFR) Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," known as the license renewal rule, was adopted by the U.S. Nuclear Regulatory Commission (NRC) allowing it to renew these licenses for a period up to an additional 20 years. This license renewal rule addressed the safety and technical requirements for extended license term, and the renewal is based on the NRC's assessment of the plant's operational safety, including environmental protection, being assured during the 20-year period of extended operation (PEO). Neither the Atomic Energy Act of 1954 (as amended) nor the subsequent NRC regulations for renewal include any specific limitations as to the number of times a license may be renewed.

"License renewal" (LR) is the process used in the U.S. for an NPP to request, using a license renewal application (LRA), renewal of the plant's operating license for an additional 20 years of operation and the NRC staff to review and evaluate the acceptability of the LRA. The license may be renewed for an additional operating period up to 20 years. The term "subsequent license renewal" (SLR) refers to the second (or subsequent) renewal of a license that was previously renewed. For example, SLR may approve continued operation for the period from 60 to 80 years. SLR also refers to the process for applicants to submit an LRA for the staff to review and evaluate.

The term "period of extended operation" or PEO is used in 10 CFR 54.3 in the definition of "integrated plant assessment" (IPA). This term describes plant operation beyond the initial 40-year license term; for example, plant operation from 40 to 60 years under a renewed license. The period from 60 to 80 years is referred to in this TLR as the "subsequent period of extended operation." In addition, "long term operation" (LTO) is sometimes used in the U.S. to refer to NPP operation beyond the initial 40-year license period, and is used internationally to describe plant operation beyond the original design or license period.

Pursuant to 10 CFR Part 54, the staff has reviewed and approved, as of May 2016, 83 units (81 operating plants with renewed licenses) for an additional 20 years of operation beyond the initial license period. The first LRA was submitted to NRC in April 1998, and the last application for a first renewal is scheduled to be submitted in 2022. The staff expects that essentially all licensees with operating reactors will request an initial license renewal. Furthermore, 41 units have entered the PEO.

Based on public meetings with the Nuclear Energy Institute (NEI), some licensees are considering submitting applications for the subsequent period of extended operation (i.e., for plant operation beyond 60 years). The first of these applications could possibly be submitted as early as 2018.

To ensure the quality and uniformity of SLR applications reviews, the NRC is developing guidance documents for the technical review of applications for SLR, i.e., that would authorize

plant operation beyond 60 years. The current license renewal guidance documents (LRGDs) used for the review of LRAs for operation up to 60 years are the "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" (NUREG-1800) and the Generic Aging Lessons Learned (GALL) Report (NUREG-1801). An important part of this LRGD development for SLR is the identification of aging effects for systems, structures, and components (SSCs) within the scope of the license renewal rule that would be important to consider for plant operation beyond 60 years, along with the development of aging management programs (AMPs) that will be effective in managing the identified aging effects.

To facilitate development of these LRGDs, the NRC Office of Nuclear Regulatory Research (RES) has been tasked by the NRC Office of Nuclear Reactor Regulation (NRR) to identify and evaluate aging management of SSCs during an SLR period. Argonne National Laboratory (Argonne) provided technical support to the staff to develop LRGDs for technical review of applicant submittals for SLR of NPPs beyond 60 years.

The approach to develop the necessary staff guidance documents builds upon the base developed for the review of initial LRAs, for operation to 60 years. The additional considerations for SLR, related to aging management reviews and aging management programs, include the following:

- identify aging effects that require aging management during SLR, with an emphasis on aging effects that can become more severe during SLR
- develop AMPs to manage the aging effects identified for SLR. These AMPs can be:
    - Existing AMPs developed to support the initial PEO
    - Modifications to existing AMPs to improve their effectiveness in managing the expected aging effects for the SLR
    - New AMPs developed to address aging effects specific to the SLR

As part of its work to support this LRGD development activity, the NRC conducted "AMP Effectiveness Audits" to provide an understanding of how AMPs have been implemented by plants during the PEO and the degradation that has been identified by the AMPs. The results from these audits will provide key information to aid the NRC to identify needed changes to existing AMPs and new AMPs that may be needed to provide assurance of safe plant operation during an SLR operating period. The scope of these AMP Effectiveness Audits addressed:

- Understanding how the AMPs have been implemented by licensees during the PEO (e.g., the types of component inspections that have been conducted and any access impediments for the inspections)
- Reviewing the findings from the AMPs in terms of the types of degradation that have been identified
- Identifying how the AMPs have changed based on plant-specific and industry operating experience

The LRA for Ginna was submitted on August 1, 2002, and the renewed license was issued on May 19, 2004, technically supported by the "Safety Evaluation Report Related to the License Renewal of the R. E. Ginna Nuclear Power Plant," issued as NUREG-1786. Ginna entered the period of extended operation beyond 40 years on September 19, 2009. NMP-1 submitted an LRA on May 27, 2004, and the renewed license was issued on October 31, 2006, technically supported by the "Safety Evaluation Report Related to the License Renewal of Nine Mile Point Nuclear Station, Units 1 and 2," issued as NUREG-1900. NMP-1 entered its period of extended operation on August 22, 2009. HBRSEP submitted an LRA on June 17, 2002, and the renewed license was issued on April 19, 2004, technically supported by the "Safety Evaluation Report Related to the License Renewal of H. B. Robinson Steam Electric Plant, Unit 2", issued as NUREG-1785. HBRSEP entered its PEO on July 31, 2010.

Staff from NRR and RES conducted onsite audits during August/September 2011 at Ginna, during November 2011 at NMP-1, and during January 2013 at HBRSEP. The staff reviewed the licensee's implementation of the AMPs and findings from the AMPs, including confirmatory findings of no degradation as well as adverse or unexpected aging effects. Among the areas considered by the staff during its audit activities were the following:

- Inspection accessibility issues, adequacy of inspection methods, and frequency of inspections
- Unanticipated structure and component degradation, related equipment failures, or premature repair/replacement
- Trending information that can yield insights regarding the actual effectiveness of the current AMPs and aging management reviews (AMRs)

The types of information reviewed by the audit team included the following:

- Available results of licensee health reports/assessments of the AMPs
- Sample results from the nonconformance reporting system related to plant aging
- Licensee evaluation of site-specific and industry operating experience
- Changes made to AMP

Any related information about the adequacy of the current AMPs that will assist in the development of guidance for SLR aging management processes and programs.

The audits reviewed mechanical system AMPs, structural system AMPs and electrical system AMPs. In addition, AMPs associated with time-limited aging analyses (TLAAs) were also reviewed, as applicable. The audit process involved onsite interviews of licensee plant personnel by the staff, with additional participation by telephone by both the staff and, for the mechanical and structural AMPs, Argonne staff.

This TLR provides the staff's observations from the AMP Effectiveness Audits for mechanical systems, structures, and electrical systems for the Ginna, NMP-1, and HBRSEP NPPs for the PEO.

The LRAs for Ginna, NMP-1, and HBRSEP, submitted in 2002, 2004, and 2002 (Table 1.1 below) were based on the guidance of Revision 0 of NUREG-1800 and Revision 0 of NUREG-1801, and the AMPs for these three plants were generally prepared in conformance with this guidance. Although there is not a precise correlation between the AMPs currently listed in the latest version of the GALL Report (NUREG-1801, Rev. 2), and those used and audited at Ginna, NMP-1, and HBRSEP, the audit team used the GALL Report, Rev. 2 as an information source for the audits. The objective was to learn how to enhance the existing LRGDs towards SLR application.

Issue / Rx	Ginna	NMP-1	Robinson
Reactor Type	West. 2-loop PWR	Mark-1 BWR	PWR
LRA Submitted	8/1/2002	5/27/2004	6/17/2002
License Renewal	5/19/2004	10/31/2006	4/19/2007
SER	NUREG-1786	NUREG-1900	NUREG-1765
Entrance into PEO	9/19/2009	8/22/2009	7/31/2010
AMP Effectiveness Audit	Aug/Sept 2011	Nov 2011	Jan 2013

Table 1.1 Key Attributes of Plants Audited for SLR Considerations

Following each AMP Effectiveness Audit, the licensee for each plant was provided a short letter summary to ensure factual accuracy; significant comments provided by each licensee were incorporated in the report. Some of the findings enclosed in this public TLR were based on the opinion of the contractors and the factual accuracy was not subsequently verified. We especially acknowledge the facilitation and review and comments by Michael Fallin, Constellation Energy Nuclear Group, LLC (for Ginna and NMP-1 audits) and by Al Maysam of HBRSEP for the HBRSEP audit.

The audits reviewed mechanical system AMPs, structural system AMPs and electrical system AMPs. In addition, AMPs associated with time-limited aging analyses (TLAAs) were also reviewed, as applicable. The audit process involved onsite interviews of licensee plant personnel by the staff, with additional participation by telephone by both the staff and, for the mechanical and structural AMPs, Argonne staff.

For each AMP, this TLR identifies good practices (or strengths), as well as areas that may require further consideration for SLR. The assessments focus on the adequacy and implementation of the AMPs described in GALL, Rev. 2, for the subsequent renewals. It is recognized that the GALL Report provides just one way of implementing an acceptable AMP for managing the aging effects so that the intended functions of all safety-significant SSCs are maintained during the PEO. A licensee may have taken some exceptions and excluded some components of the GALL AMP or added enhancements to make the AMP more effective. Alternatively, the applicant may propose an alternative AMP and submit it for review and approval by the NRC staff. Such changes and their justification are being considered in these assessments.

It is recognized that the GALL Report provides just one avenue for implementing an acceptable AMP for managing the aging effects so that the intended functions of safety-significant SSCs are maintained during the PEO. A licensee may have taken some exceptions to the GALL Report AMP or identified enhancements either to make their plant-specific AMP consistent with the GALL Report AMP or to address plant-specific considerations, including operating experience, to ensure adequate aging management.

Once sufficient information has been gathered from future AMP Effectiveness Audits, other RES publications, and comments from interested stakeholders, the information will be evaluated to identify:

- Effects of aging that need to be managed during an SLR operating period
- Changes to existing license renewal AMPs to improve the performance of the AMPs for management of aging effects during the SLR operating period
- New AMPs that need to be added for the SLR operating period.

1.1 License Renewal Process

For operating NPPs, a license is renewed on the basis that the current licensing basis (CLB) continues to remain valid and additional measures are taken, identified as “aging management,” such that the intended functions of the SSCs within the scope of license renewal are maintained during the PEO. 10 CFR 54.3 states:

> “Current licensing basis (CLB) is the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect. The CLB includes the NRC regulations contained in 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 52, 54, 55, 70, 72, 73, 100 and appendices thereto; orders; license conditions; exemptions; and technical specifications. It also includes the plant-specific design-basis information defined in 10 CFR 50.2 as documented in the most recent final safety analysis report (FSAR) as required by 10 CFR 50.71 and the licensee's commitments remaining in effect that were made in docketed licensing correspondence such as licensee responses to NRC bulletins, generic letters, and enforcement actions, as well as licensee commitments documented in NRC safety evaluations or licensee event reports.”

10 CFR 54.33(b) states, in part, that:

> “Each renewed license will be issued in such form and contain such conditions and limitations, including technical specifications, as the Commission deems appropriate and necessary to help ensure that systems, structures, and components subject to review in accordance with § 54.31 will continue to perform their intended functions for the PEO. In addition, the renewed license will be issued in such form and contain such conditions and limitations as the Commission deems appropriate and necessary to help ensure that systems,

structures, and components associated with any time-limited aging analyses will continue to perform their intended functions for the PEO."

The license renewal process is initiated with the receipt and docketing of an LRA. An LRA contains an IPA and an evaluation of time-limited aging analyses (TLAAs), as defined in 10 CFR 54.21(c). As described in 10 CFR 54.21(a), the IPA is a licensee assessment that demonstrates that a nuclear power plant facility's structures and components requiring aging management review (AMR), in accordance with scope of license renewal, have been identified and that the effects of aging on the functionality of such structures and components will be managed to maintain the CLB such that there is an acceptable level of safety during the PEO.

10 CFR 54.21(a)(3) further states that, for each structure and component identified as in scope for license renewal, the IPA shall demonstrate that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the PEO.

From the perspective of demonstrating that the effects of aging will be adequately managed during the PEO, the essential elements of the AMR described in 10 CFR 54.21 involve:

- Identifying the SSCs within the scope of license renewal
- For those SSCs identified above, identifying the aging effects that require aging management
- Identifying the aging management that will ensure the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the PEO

In the United States, all SSCs in an NPP are designed in accordance with the requirements contained in: (a) applicable general design criteria (GDC) in 10 CFR 50 Appendix A; (b) 10 CFR 50.55a "Code and Standards," which include the requirements of relevant Subsections of the ASME Boiler and Pressure Vessel Code; and (c) 10 CFR 52 "Early Site Permits, Standard Design Certification, and Combined License for Nuclear Power Plants," as well as the acceptance criteria specified in the "Standard Review Plan" NUREG-0800. Compliance with the above requirements and meeting the acceptance criteria ensure that the SSCs important to safety are constructed and tested to quality standards commensurate with the importance of the safety functions performed, and that the SSCs are designed with appropriate margins to withstand effects of anticipated operational occurrences (AOO) and normal operation, natural phenomena such as earthquakes, postulated maximum credible accidents including loss of coolant accidents (LOCAs), and events and conditions external to the NPP, such as loss of offsite power (LOP).

According to 10 CFR 50.2, the design basis is that information which identifies the specific functions to be performed by a SSC of a plant, and specific values or ranges of values that are set for controlling parameters as reference bounds for design. These values may be (a) limits or constraints derived from generally accepted "state-of-the-art" practices for achieving functional goals, or (b) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated plant-specific accident for which an SSC must meet its functional goals.

For operating NPPs, a license is renewed on the basis that the current licensing basis (CLB) continues to remain valid and the intended functions of the SSCs important to safety are maintained during the PEO. The plant's CLB per 10 CFR 54.3 includes the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within the applicable NRC requirements, as well as the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect. According to the license renewal rule, the plant's CLB is maintained throughout the renewal period, in part through the comprehensive AMPs, and through regulatory processes that may include licensee commitments to inspection corrective action programs, and specific regulatory directives such as generic letters, bulletins, security orders, backfit, and license amendments.

As described in the Branch Technical Position RLSB-1 in Appendix A of the SRP-LR, the license renewal process is not intended to demonstrate absolute assurance that structures and components will not fail, but rather to provide reasonable assurance that they will perform such that the intended functions are maintained consistent with the CLB during the PEO. Furthermore, a program based solely on detecting structure and component failure should not be considered as an effective AMP for license renewal. Thus, an effective management of aging degradation is achieved by means of a comprehensive AMP that consists of several aging management activities (AMAs). Further details of the AMR process and description of ten elements of an acceptable AMP are presented in the Branch Technical Position RLSB-1 in Appendix A of the SRP-LR.

Thus, in accordance with the SRP-LR methodology to clearly establish the CLB at the start of a license renewal period and to fully meet the intent of the SRP-LR methodology for maintaining the CLB throughout the renewal period, and based on their insights from two decades of work, ANL staff felt that LRAs could be enhanced by the following optional augmentation:

(1) An assessment of the effects of all applicable age-related degradation processes and mechanisms for safety significant SSC on the plant's design basis analyses (DBA), and

(2) A detailed description of the applicant's AMPs to manage these aging effects, including an evaluation of the intended functionality and remaining margins, demonstrating that CLB remains valid during the extended period.

Typically, the applicant's AMPs are described and evaluated in the LRA. An assessment of the impact of the postulated aging effects on the plant's design bases is not included in the LRA. Such information is generally available in the applicant's responses to various regulatory directives.

1.2 Subsequent License Renewal

The license renewal process involves primarily passive structures and components; however, their degradation may not be as readily apparent as the degradation of active structures and components. Particularly, it has not been as yet possible to predict the time for the onset of degradation, e.g., crack initiation due to any known mechanisms. Also, the capability to reliably detect the initiation of degradation is not yet available, although once degradation has initiated and progressed, it has been possible to detect such degradation, as documented by operating experience. It is generally agreed in the technical community that during operation beyond 60 years there may exist the possibility of: (a) the onset of previously known degradation

mechanism, but not yet observed during the 40 years of operation; (b) the acceleration of degradation already observed and accounted for in the respective AMP; and (c) the emergence of new mechanisms, particularly related to operation beyond 60 years.

To ensure that the design basis remains valid during the PEO, an aging management review (AMR) is conducted to identify age-related degradation of reactor structures and components. Depending on the materials of the components and structures and reactor service conditions, such as temperature, reactor coolant water chemistry, cumulative neutron irradiation dose, and imposed stress, and their fluctuations during service, the age-related degradation process may include, but is not limited to (a) material loss due to corrosion, corrosion/erosion, or wear; (b) cracking due to intergranular stress corrosion cracking (IGSCC), transgranular stress corrosion cracking (TGSCC), primary water stress corrosion cracking (PWSCC), or irradiation assisted stress corrosion cracking (IASCC); (c) fatigue strength reduction due to corrosion fatigue; (d) loss of ductility and fracture toughness due to void formation, neutron irradiation and/or thermal embrittlement, including synergistic effects of neutron/thermal embrittlement; (e) loss of preload due to thermal and/or irradiation enhanced stress relaxation; and (f) change in dimension due to void swelling. Some of these effects may involve TLAAs that may not have been significant during the initial 40- or 60-year service and, therefore, were not included in the DBA or the plant's technical specifications.

Based on their previous experience, ANL staff felt that it is worth noting that the extent of potential erosion of the original design margins due to the effects of normal operation and other AOOs as well as that due to aging-related degradation is largely unknown. Furthermore, whether the design margin erodes gradually over time or suddenly due to some unknown causes is also not well understood, and such information is not considered in risk assessments. This weakness, in fact, contributes to both data and model uncertainty in evaluating the risk due to passive component degradation. If and when degradation is observed – for example, cracking in dissimilar metal welds (DMWs) – a flaw tolerance evaluation is performed to justify continued operation or component replacement or repair per ASME rules. The sufficiency of this procedure for extended operation depends on the robustness of degradation models, the efficacy of the licensee's AMP, and the safety significance analysis conducted by the licensee and reviewed and approved by NRC staff. Probabilistic arguments may be used to develop an approach for aging management adequacy, and the risk significance of a structure or component could be considered in evaluating the robustness of an AMP. However, use of probabilistic arguments may need to be supported by some experimental data and operating experience.

Another critical element of the AMR process is establishing an adequate inspection interval for critical areas of SSCs that are susceptible to degradation and providing appropriate means to examine such areas using proper techniques. Similarly, the ANL staff suggest for consideration that the effects of any modifications made to the plant SSCs on the DBA be assessed for the PEO, and the analyses be updated or revised to incorporate the effects of these modifications. Examples of such modifications include extended power uprate (EPU), or replacement of a steam generator or reactor vessel head. The effects of these uncertainties should be considered in the AMR process to define the AMPs that are needed to manage the aging effects on the intended function of the SSCs, and to identify the different activities within each AMP.

Moreover, for license renewal for SLR beyond 60 years, the ANL staff suggest to consider to verify and/or demonstrate that the DBA (e.g., ASME Section III, Subsections NB or NG, or any other Codes and Standards used in the plant design) are valid for the PEO, which means that

potential erosion of the design margin on critical areas of SSCs has been evaluated and addressed. For example, the applicant may need to ensure that the materials properties that were used still meet the CLB requirements, so that the design safety margins are still valid, or when the components are replaced the new margins need to meet the original margin or have been reviewed/approved for a specific exception. If the plant service conditions are likely to change the properties (to meet the requirements of ASME Code Section NB-2160 or NB-3121, or 3124, etc.), the applicant may need to provide an update/revision of the appropriate DBA to ensure that they remain valid for extended operation. These three Code subsections set design rules considering possible effects of service conditions, such as temperature, reactor coolant environment, or neutron irradiation, on mechanical properties (e.g., tensile strength, fatigue strength, and fracture toughness) of structural materials.

In addition, for most plants the original DBA were performed during the decade of 1960 or 1970. Some of the methodology or the information used in performing these analyses has changed since then. For these older NPPs and plants that have undergone many modifications over their lifetimes, it would be advisable for the LRA to identify all significant modifications to the original design basis and the corresponding documentation cited through one of the three main processes: (a) license amendment, (b) FSAR update, or (c) Part 50.59 evaluation/approval.

This effort could potentially involve revising/updating DBA including TLAAs (e.g., leak before break [LBB] or flaw tolerance analyses, fatigue cumulative usage factor [CUF] analyses including environmental effects, corrosion or erosion/corrosion allowances, etc.). There could also be a need to conduct additional TLAAs that were not in the original DBA (e.g., decrease of fracture toughness of austenitic stainless steels (SSs) and Ni-alloys due to thermal or neutron embrittlement and decrease in ductility) but become relevant due to the extended term beyond the original design basis term of operation.

It is likely that some of these analyses may not meet criterion #6 of 10 CFR 54.3, which states that TLAAs are those licensee calculations and analyses that are contained or incorporated by reference in the CLB. Therefore, unless these analyses are included in the plant's CLB, they are not considered a TLAA and need not be evaluated for license renewal. As indicated in the license renewal rule, in accordance with 10 CFR 54.30, the adequacy of the plant's CLB, which includes TLAAs, is not an area within the scope of the license renewal review. Any questions regarding the adequacy of the CLB are addressed under the backfit rule (10 CFR 50.109) and are separate from the license renewal process. This apparent inconsistency in the SRP-LR process may need to be re-evaluated and addressed for SLR.

1.3 Report Content

This TLR documents analyses conducted by ANL on behalf of RES and provides information that is related to two areas, namely, an assessment of the AMP effectiveness audit conducted by NRC staff and some perspectives resulting from the audit results that may be applicable for SLR. Many of the observations come from ANL's extensive experience in reviewing LRAs. The audit relevant for SLR is compiled for each AMP in separate worksheets enclosed in Appendix A for Ginna and NMP-1 and in Appendix B for HBRSEP. The source of this information includes the audit reports from staff's visits to the Ginna, NMP-1, and HBRSEP NPPs and reviews of SERs for LRAs as well as extensive supplemental information. Section 2 briefly reviews the applicability of current LRGDs to SLR and the information that might be relevant for SLRGDs, and it highlights possible modifications that may be necessary in that approach. A generic evaluation of the information for the various AMPs and lessons learned is presented in

Chapter 3, and strengths of the AMPs and areas that may require further consideration or enhancement for SLR are identified. An evaluation of the effectiveness of current individual mechanical, structural, and electrical AMPs to support development of SLR AMPs is presented in Chapter 4 for Ginna and NMP-1 and in Section 5 for RNP.

SECTION 2
Updating GALL Report Guidance for LTO

This chapter briefly reviews the applicability of the GALL approach to license renewal for LTO and the information that might be relevant for developing guidance for LTO, and it highlights possible modifications that may be necessary in that approach.

The GALL Report has undergone two revisions since its first publication in April 2001. The Ginna, NMP-1, and HBRSEP plant LRAs, as well as those for a number of other plants, were prepared and subsequently evaluated under GALL, Rev. 0, guidance. Several AMPs in GALL, Rev. 0, have been extensively revised in Rev. 2, and other AMPs in Rev. 2 did not exist in Rev. 0. Specifically, GALL, Rev. 2, AMPs XI.M36 ("External Surfaces Monitoring of Mechanical Components") and XI.M38 ("Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components") are not found in Rev. 0, and the LRAs for Ginna and NMP-1 describe plant-specific AMPs to deal with the aging management issues addressed in these two GALL AMPs. However, as not unexpected, the details of these plant-specific programs do not conform entirely to the inspection requirements laid out in the Rev. 2 AMPs. GALL, Rev. 2 AMP XI.M40 ("Monitoring of Neutron-Absorbing Materials other than Boraflex") is another example of an AMP not found in Rev. 0, and both Ginna and NMP-1 have again developed plant-specific programs to manage the corresponding aging effects.

The current AMPs in GALL, Rev. 2, do not consider LTO or SLR and therefore do not address the question of whether these plants must update their AMPs to conform to the latest edition of the GALL Report prior to entering LTO. For SLR beyond 60 years, it is desirable for the applicant's AMPs to conform to the AMP structure contained in the most recent edition of the GALL Report or the most recent specific staff guidance.

The applicability of the ASME Boiler and Pressure Vessel Code, Code Cases, and their updates to license renewal is discussed in Chapter 1 of GALL, Rev. 2. As noted in this chapter, In 1971, the Atomic Energy Commission incorporated the ASME Code into the regulations in 10 CFR 50.55a in 1971, and the NRC periodically amends 10 CFR 50.55a and issues Federal Register Notices (FRNs) about this rule in order to endorse, by reference, newer editions and ASME Code Addenda subject to the modifications and limitations identified in 10 CFR 50.55a. Except where noted and augmented in the GALL Report, the following ASME Section XI editions and addenda are presently acceptable and should be treated as consistent with the GALL Report: (1) from the 1995 edition to the 2004 edition, as modified and limited in 10 CFR 50.55a, and (2) more recent editions, as evaluated for their adequacy for license renewal and discussed in the accompanying FRN. The licensee is required to amend its CLB by updating its ASME Section XI edition and addenda of record to the most recently endorsed edition and addenda referenced in 10 CFR 50.55a one year prior to entering the next 10-year internal inservice inspection (ISI) for its unit.

It was noted during the audit process that several GALL AMPs cite inspection requirements of ASME Code Section XI, Subsection IWB, Table IWB-2500-1. However, the details of specific requirements of various examination Categories in Table IWB-2500-1 vary depending upon the edition of the Code. For example, the inspection requirements for reactor head closure studs or pump casing have changed between 1995 edition and 2004 edition of the Code. Clearer

guidance needs to be provided for licensees currently following Section XI, ISI, in accordance with1995 to 2000 editions of the ASME Code, but who plan to follow 2001 or later editions for future inspections. In the larger picture, the GALL Report guidance on the optional and required use of updated ASME Code requirements needs to be reviewed and revised as necessary.

Finally, the GALL references to NRC guidance (Regulatory Guides, Interim Staff Guidance, Generic Letters, etc.) should be reviewed and updated prior to applying GALL to LTO. Guidance of this type is cited in a number of GALL, Rev. 2 AMPs, but it was noted during the audits that some significant references are absent. For example, while AMP XI.M3 ("Reactor Head Closure Stud Bolting") references NRC Regulatory Guide (RG) 1.65, it fails to include the recommendation of RG 1.65 regarding protecting the studs and stud bolt holes in the vessel flange from corrosion and contamination during the venting and filling of the pressure vessel while the head is removed. Likewise, GALL XI.M31 ("Reactor Vessel Surveillance") does not reference NRC RG 1.190, which was issued in March 2001 and provides state-of-the-art calculations and measurement procedures that are acceptable to the NRC staff for determining pressure vessel fluence.

2.1 Aging Management Programs (AMPs)

Pursuant to 10 CFR 54.21 (a)(3), a license renewal applicant is required to demonstrate that the effects of aging on structures and components subject to an AMR are adequately managed so their intended functions will be maintained consistent with the CLB for the PEO. As part of the license renewal process, a licensee must (a) identify all aging effects that potentially could cause degradation of structures and components, and (b) define a comprehensive AMP to manage these aging effects such that the intended function of the structures and components will be maintained during the PEO. The license renewal process is not intended to demonstrate absolute certainty that structures and components will not fail, but rather that there is reasonable assurance that they will perform such that the intended functions are maintained consistent with the CLB during the PEO.

The Branch Technical Position RLSB-1 in Appendix A of the SRP-LR provides a discussion of a generic AMPs. The RLSB-1 states that there are four types of programs : (i) prevention: precludes the effects of aging (e.g., coating); (ii) mitigation: attempts to slow down the effects of aging (e.g., water chemistry control); (iii) condition monitoring: involves inspection to detect the presence and extent of aging effects (e.g., periodic ISIs); and (iv) performance monitoring: that tests the ability of the structure or component to perform its intended function (e.g., tests the heat transfer capability of heat exchanger tubes). Typically, more than one type of program is implemented to ensure that aging effects are managed adequately. For example, the BWR Stress Corrosion Cracking program typically includes condition monitoring as well as mitigation actions to manage stress corrosion cracking (SCC) in the BWR piping system.

Effective management of aging degradation is achieved by means of a comprehensive AMP that may consist of condition monitoring as well as mitigation actions as proposed in the GALL Report AMPs. Therefore, for clarity, in the current report the programs proposed in the GALL Report for managing various aging degradation effects are called AMPs, and the various components of the program (such as condition monitoring or mitigation action or performance monitoring) are called AMAs. Each one of these AMAs may include several actions.

The AMPs contained in different revisions of the GALL Report follow a common format as shown in Table 2.1. Each AMP begins with a program description that summarizes the aging

effects and their associated aging degradation mechanisms that need to be managed, and the various AMAs that are recommended in the AMP to adequately manage the aging effects such that the intended functions of the in-scope components will be maintained during the PEO.

Table 2.1 Elements of an Aging Management Program for License Renewal

Element	Description
Program Description	Summary, in no more than a few paragraphs, of the aging effect(s) to be managed, the aging mechanism(s) responsible for the aging effect(s), the overall approach proposed to manage the aging effect(s), and the technical basis for this approach.
1. Scope of Program	Scope of program includes the specific structures and components subject to an AMR for license renewal.
2. Preventive Actions	Preventive actions should prevent or mitigate aging degradation.
3. Parameters Monitored or Inspected	Parameters monitored or inspected should be linked to the degradation of the particular structure or component-intended function(s).
4. Detection of Aging Effects	Detection of aging effects should occur before there is a loss of structure or component-intended function(s). This includes aspects such as inspection method or technique (i.e., visual, volumetric, surface inspection), frequency, sample size, data collection, and timing of new/one-time inspections to ensure timely detection of aging effects.
5. Monitoring and Trending	Monitoring and trending should provide predictability of the extent of degradation, and timely corrective or mitigative actions.
6. Acceptance Criteria	Acceptance criteria, against which the need for corrective action will be evaluated, should ensure that the structure or component-intended function(s) are maintained under all CLB design conditions during the PEO.
7. Corrective Actions	Corrective actions, including root cause determination and prevention of recurrence, should be timely.
8. Confirmation Process	Confirmation process should ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective.
9. Administrative Controls	Administrative controls should provide a formal review and approval process.
10. Operating Experience	If the AMP is an existing program, operating experience of the AMP, including past corrective actions resulting in program enhancements or additional programs, should provide objective evidence to support the conclusion that the effects of aging will be managed adequately so that the structure- and component-intended function(s) will be maintained during the PEO.
References	References for AMP citations and to NRC (and other, as appropriate) guidance should provide enough information to apply the above ten elements.

The program description is followed by more detailed description of an acceptable technical approach to the management of the aging effects with respect to each of the ten program elements of the AMP. For each AMP, all AMAs that are identified in the AMP for managing the applicable aging effects for specific structures or components are described and evaluated together for the ten program elements of the AMP. The description of these program elements is as shown above in Table 2.1.

Chapters 4 (for Ginna and Nine Mile Point 1) and Chapter 5 (for HB Robinson) of this TLR present a detailed evaluation of each of the mechanical and structural systems AMPs contained in GALL, Rev. 2, and include a number of proposed revisions and enhancements to these AMPs to improve their applicability to subsequent license renewal for LTO. These suggested revisions include not only technical updates and clarifications in wording, but also changes in the scope and requirements of some AMPs in order to meet the new demands associated with operation beyond 60 years. These suggestions are based on information obtained during the audits recently conducted at Ginna, Nine Mile Point 1, and HB Robinson on reviews of SERs for these and other LRAs, as well as extensive supplemental information. Some of the more significant findings are summarized below in general terms.

2.1.1 One-Time Inspection

GALL, Rev. 2 endorses use of the One-Time Inspection AMP (XI.M32) as a means of verifying the effectiveness of the following AMPs prior to entering the period of extended operation, provided the period of extended operation is expected to be equivalent to that in the prior 40 years and no aging effects have been observed: XI.M2, “Water Chemistry”; AMP XI.M30, “Fuel Oil Chemistry”; and AMP XI.M39, “Lubricating Oil Analysis,”. NUREG-1801 notes that the scope of this program also may include verification of the effectiveness of additional AMPs for other components and materials where the same restrictions apply. This one-time inspection is to be performed in a designated time period prior to entering the period of extended operation. However, GALL, Rev. 2 does not address LTO, and so it does not explicitly state that a similar one-time inspection should be performed prior to entering subsequent periods of extended operation. This requirement should be spelled out in subsequent GALL updates. Also, in view of the increased service times of the components subject to inspection, the details of the program with respect to sample size and sampling and inspection techniques should be reviewed on a plant-specific basis to ensure that the program is sufficiently rigorous to detect degradation that was not detectable after 40 years but has become significant after an additional 20 years.

The One-Time Inspection AMP may be a particularly valuable tool in verifying the continued effectiveness of several AMPs prior to entering LTO in addition to those specifically mentioned in GALL, Rev. 2. These AMPs include XI.M3 (“Reactor Head Closure Stud Bolting”), XI.M10 (“Boric Acid Corrosion”), XI.M17 (“Flow-Accelerated Corrosion”), XI.M18 (“Bolting Integrity”), XI.M27 (“Fire Water System”), XI.M33 (“Selective Leaching”), and XI.M41 (“Buried and Underground Piping and Tanks”), among others. In all cases, a one-time inspection is applicable only if no aging effects have been observed prior to and during the initial period of extended operation prior to LTO. Where aging effects have been observed, periodic inspections will generally be required.

2.1.2 Reactor Vessel Surveillance

Extended operation beyond 60 years increases the likelihood that a number of licensees will exhaust their supply of surveillance capsules in the reactor vessel. This means that they will increasingly be forced to rely on the alternatives given in GALL AMP XI.M31 ("Reactor Vessel Surveillance"). Currently, program element 4 of GALL XI.M31 recommends that if all surveillance capsules have been removed, a licensee may seek membership in an integrated surveillance program unless the integrated surveillance program does not have surveillance material representative of its limiting beltline materials. Alternatively, the program can propose one of the following: (a) an active surveillance program with reinstituted specimens or (b) an alternative neutron monitoring program. However, further evaluation may be needed to confirm that either of the foregoing two options is sufficient to adequately manage aging. Both options may possibly be necessary in some cases. In addition, GALL does not provide detailed guidance for an Alternative Neutron Monitoring Program. For LTO, the GALL options with respect to alternative surveillance programs should be reevaluated, and detailed guidance on an alternative neutron monitoring program should be provided.

2.1.3 Additional Degradation Processes

The audits turned up to two examples of aging-related degradation processes that did not appear to be addressed in GALL, Rev. 2. Ginna observed increased roughness at the inner surfaces of open-cycle cooling water system piping due to the formation of tubercules and other fouling mechanisms. The operative mechanism is probably microbiologically influenced corrosion (MIC), which is explicitly discussed in AMP XI.M20 ("Open Cycle Cooling Water System"). However, this AMP does not appear to consider the potential impact of increased surface roughness on assumptions related to required flow in the auxiliary feedwater supply piping in the event of a LOCA. Similarly, the potential for stress corrosion cracking of thin-walled sensitized SS at temperatures less than 140°F was raised and later dismissed. This issue is specifically addressed in NRC Information Notice 2011-04, but there does not appear to be a corresponding AMR line item in GALL, Rev. 2. Following the AMP audits, the license renewal interim staff guidance (LR-ISG) 2012-02 was written that added new corresponding AMR line-items.

2.2 Operating Experience

As a general observation, it is noted that there is no applicable OpE available to guide the extension of operating licenses for nuclear power plants beyond 60 years. Consequently, a conservative approach should be adopted, and the aging management requirements for licensing beyond 60 years should be at least as stringent as those currently being used in the GALL Report for initial license renewal. Overall, the present GALL framework is considered to be technically sound and readily adaptable to license renewal for LTO. In many cases, the existing AMPs and TLAAs in GALL, Rev. 2 can be applied to LTO review with little or no modification. However, some AMPs and TLAAs may require certain revisions, updates, and enhancements, as highlighted below and discussed in more detail in Chapter 3.

However, as discussed earlier, the NRC maintains OpE databases and considers the OpE information to be a key component for (a) regulatory decisions, (b) providing needed technical bases for enhanced inspection or monitoring guidelines, (c) confirming the effectiveness of aging related programs, and (d) determining areas for additional research related to operation during potential subsequent license renewal periods. The importance of OpE in evaluating AMP

effectiveness is discussed in Section A.1.2.3.10 of NUREG-1800, Rev. 2, Appendix A. The LR-ISG 2011-05 clarifies the NRC's existing position in SRP-LR, Rev. 2 that acceptable license renewal AMPs should be informed, and enhanced when necessary, based on the on-going review of plant-specific and industry OpE. The description of the Program Element 10 "Operating Experience" in an acceptable AMP defined in Section A.1.2.3.10 of the SRP-LR includes discussions related to (a) consideration of future plant-specific and industry OpE relating to AMPs, (b) currently available OpE with existing program, and (c) currently available OpE applicable to new programs. New review procedures entitled "Ongoing Review of Operating Experience," will be added as several subsections of Section 3 of the SRP-LR, to read: "The applicant's AMPs should contain the element of OpE. The reviewer verifies that the applicant has appropriate programs or processes for an ongoing review of plant-specific and industry OpE related to aging management. Such reviews are used to ensure that the AMPs are effective to manage the aging effects for which they are credited. When these reviews indicate that the programs may not be fully effective or can be improved, the AMPs are enhanced or new AMPs are developed and implemented, as appropriate. Additional information is in Appendix A.4, Operating Experience for Aging Management Programs." The Appendix A.4 of the SRP-LR will include the acceptance criteria. On the basis of LR-ISG 2011-05, Element 10 of each AMP in the GALL-SLR includes the concluding sentence "The program is informed and enhanced when necessary through the systematic and ongoing review of both plant-specific and industry operating experience, as discussed in Appendix B of the Gall Report."

For license extension beyond 60 years, the OpE during the initial 40-to-60-year period of extended operation becomes particularly significant, since it can serve as an indicator of aging issues that develop only after extended service. Industry OpE with respect to corrosion, SCC, and fouling in components exposed to treated water should be closely monitored during the initial period of extended operation beyond 40 years to verify the continued effectiveness of these guidelines. If significant aging-related degradation issues arise, revisions to this guidance may be required. Other AMPs in GALL may require similar revisions and updates, depending upon the OpE of the applicable SSCs. Similarly, where licensee has used favorable OpE to justify exceptions to GALL, the subsequent OpE for the same SSCs should be reevaluated to determine if these exceptions continue to be justified for LTO.

Operating experience can also serve as an indicator of how effectively the licensee's AMPs, as described in their LRAs, are being implemented.

SECTION 3
Generic Evaluation of AMPs and Lessons Learned

The relevant information for license renewal for SLR, and that compiled for each AMP in separate worksheets (see Appendices A and B) as summarized in Chapter 2, was evaluated to verify the effectiveness of the AMPs in managing aging-related degradation of all safety-significant structures and components, thereby ensuring that their intended function(s) will be maintained during the PEO. The AMPs for mechanical systems, structures, and electrical systems are evaluated in separate sections. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP efficacy and (b) evaluating results of the AMP implementation.

Assessing the AMP Efficacy: The adequacy of the AMP was based on the following four aspects of the program:

1. *Management Activities of the AMP*: As described in the Branch Technical Position RLSB-1 in Appendix A of the SRP-LR and discussed earlier in Chapter 1, a program based solely on detecting structure and component failure should not be considered an effective AMP for license renewal. A detailed description of the different aspects (ten elements) of an acceptable AMP is also presented in the Branch Technical Position. In the current study, the adequacy of the program elements to effectively manage aging degradation is assessed on the basis of the adequacy of the following, based on the understanding of the aging degradation process:

   (a) Condition and/or performance monitoring guidelines, consistent with applicable requirements, to ensure timely detection and characterization of all applicable aging degradation effects;

   (b) Design modifications (material selection or replacement) to prevent or minimize degradation (e.g., use of materials that are resistant to degradation or coatings to prevent degradation), and operation within defined limits to prevent or minimize degradation (e.g., water chemistry control);

   (c) Assessment of the potential effects of plant modifications such as EPU or replacement of the steam generator or reactor vessel head or in response to NRC generic guidance or regulatory directive, on the AMP (summarized in Sections 3.1.3 and 3.2.3); and

   (d) Evaluation of the observed degradation in accordance with applicable guidelines to assess the effects of degradation on the structural and functional integrity of the SSCs.

2. *Clarity of the Program Description*: Lack of expected performance of an AMP is sometimes not due to inadequacy of the proposed program components or activities, but to a poor or confusing description of the program. The implementation of the AMP can be improved (a) if the program description clearly identifies the various activities of the AMP and their objectives, and (b) if the program guidance is based on another document referenced in the AMP, or other supporting documents are referenced in the AMP for additional guidance, such guidance is clearly defined in the program description and the documents identified. In addition, to emphasize the significance of such documents, it would be prudent to refer to these documents as basis documents or supporting documents.

3. *Deviations from the GALL Program (Exceptions/Enhancements)*: As discussed earlier, the GALL Report provides just one way of implementing an acceptable AMP for managing aging. A licensee may take some exceptions and exclude some components of the GALL AMP or add enhancements to improve the AMP to make it more effective, or the applicant may propose an alternative AMP. In the current study, such changes or deviations and their reasons are tracked to determine the need to modify or update the GALL Report to be consistent with industry practice.

4. *Good Practices or Strengths*: Program Element 8 of the AMP describes the "confirmation process" that ensures that preventive actions are adequate and that appropriate corrective actions have been completed and are effective. For example, water chemistry control may be used to minimize corrosion or stress corrosion cracking (SCC) in reactor pressure boundary components exposed to the reactor coolant environment. However, it may be necessary to include a one-time-inspection program to verify that such degradation processes are indeed not occurring or insignificant. Similarly, when corrective actions are necessary, there should be follow-up activities to confirm that the corrective actions have been completed, a root cause determination was performed, and recurrence of the aging degradation effect will be prevented. Furthermore, Program Element 9 describes administrative control, which recommends periodic review of OpE to identify areas where the AMP may be enhanced or new programs developed. Implementation of such activities is considered a good practice or strength.

Evaluating Results of the AMP Implementation: The effectiveness of an AMP to manage aging effects depends directly on how well it is implemented. Even a comprehensive, well-planned AMP may not be effective in controlling aging effects, if improperly implemented. Therefore, the implementation of the AMP was evaluated by examining "confirmation process" and "administrative control" program elements as well as the OpE for the AMP, including past corrective actions, root cause analyses, trending evaluations, or health reports. These documents provide objective means to identify areas that may require procedural changes to improve the capability of the AMP to manage aging effects, or to check whether the licensee has effectively used these documents to modify its AMP or improve implementation of the AMP. As documented in Section A.1.2.3.10, "Operating Experience," of Appendix A, "Branch Technical Position," the NRC staff places great value on aging-related OpE in determining and verifying the effectiveness of an AMP, particularly a new AMP. In the current study, aging-related OpE is used as a marker for assessing the adequacy of implementation of an AMP.

3.1 AMPs for Mechanical Systems (XI.M AMPs)

The 38 AMPs numbered XI.M1 through XI.M41 in Chapter XI of the GALL Report and one AMP numbered X.M1 in Chapter X of the report for mechanical systems are discussed in this section. The program description of the AMP summarizes, in no more than a few paragraphs, the aging effect to be managed, the aging mechanism(s) responsible for this effect, the overall approach proposed to manage this aging effect, and the technical basis for this approach. In general, the program descriptions provided in GALL, Rev. 2, as well as those in the Ginna, NMP-1 and Robinson AMPS for mechanical systems, met these objectives. Furthermore, the GALL Report, Rev. 2, states that this program element should include the specific structures and components that are subject to an aging management review. A brief description of the ten program elements of the AMP is presented in Chapter 2.

Over the course of the AMP reviews and audits, the following strengths (or good practices) and areas that may require further considerations or enhancements were identified. As discussed above these are divided into two sections, (a) adequacy of the GALL, Rev. 2, program description and (b) effectiveness and implementation of the AMP. A third section discusses briefly the effects of plant modifications such as EPU or replacement of reactor vessel head or steam generator, on the AMPs. The adequacy of the program is further divided into three subsections, (i) management activities of the AMP, (ii) clarity of the program description, and (iii) deviations from the GALL program (exceptions/enhancements). Each of these subsections includes an evaluation of program description, program elements 1 through 7, and OpE. The remaining two program elements, licensee's commitments, and plant-specific follow-up activities by the licensees to confirm that the corrective actions have been completed, a root cause determination was performed, and recurrence of the aging degradation effect will be prevented are discussed in the second section on effectiveness and implementation of the AMP.

3.1.1 Generic Analysis of Adequacy of the GALL Rev 2. XI.M AMPs

3.1.1.1 Program Strengths of Existing XI.M AMPS

Good Practices. In its implementation of GALL, Rev. 2 AMP XI.M3 ("Reactor Head Closure Stud Bolting"), Ginna generates and reviews program health reports for the ASME Section XI, ISI Program, which includes inspections of the reactor head closure studs. The purpose of these reports is periodic assessment and improvement of program effectiveness. Similarly, for AMP XI.M20 ("Open Cycle Cooling Water System"), the NMP-1 program health report and system health report maintain a list of relatively recent plant-specific and industry issues, including those related to the open-cycle cooling water system, along with the disposition for each item. The results of such systems provide a basis for continued improvement of program effectiveness and should be considered for inclusion as a part of program element 5 in the applicable GALL AMPs. At RNP, the licensee indicated that (1) periodic assessments of license renewal commitments and AMPs will be performed at least every three years; and that (2) the license renewal manager periodically reviews completed preventive maintenance activities that are credited for license renewal to identify potential aging effects.

3.1.1.2 Program Areas for Further Consideration

3.1.1.2.1 Management Activities of the AMP

Program Description:

1. Specific Aging Management Activities. Most AMPs in the GALL Report provide a comprehensive management program that typically consists of two or more AMAs such as condition monitoring (i.e., ISI for crack growth, wall-thinning, or loss of material), prevention or mitigation actions (e.g., water chemistry control, or use of materials more resistant to aging degradation), or performance monitoring (e.g., pressure, temperature, radiation, or flow rate monitoring). For a number of AMPs, the program description section either fails to provide a clear description of the AMAs being recommended and their significance in managing the aging effects, or if the AMP refers to guidance provided in other industry or NRC documents, codes, or standards, the program description does not include the details regarding the specific guidance being recommended. In the absence of a clear description of various AMAs, particularly the mitigation actions, some licensees have included the GALL AMP XI.M3 (Reactor Head Closure Stud Bolting) in another AMP such as XI.M1 (ASME

Section XI, Inservice Inspection Subsections IWB, IWC, and IWD). Examples of AMPs with program descriptions that do not provide adequate information regarding the various AMAs include XI.M5 ("BWR Feedwater Nozzle"), XI.M9 ("BWR Vessel Internals"), XI.M23 ("Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems"), XI.M25 ("BWR Reactor Water Cleanup System"), and XI.M26 ("Fire Protection").

2. One-Time Inspections. Several AMPs in GALL, Rev. 2 call for one-time inspections to confirm program effectiveness, either in the program description and/or in one or more of the program elements. These AMPs include XI.M2 ("Water Chemistry"), XI.M30 ("Fuel Oil Chemistry"), XI.M33 ("Selective Leaching"), and AMP XI.M39, ("Lubricating Oil Analysis"). This one-time inspection is to be performed in a designated time period prior to entering the period of extended operation. However, GALL, Rev. 2 does not address LTO, and so it does not explicitly state that a similar one-time inspection should be performed prior to entering subsequent periods of extended operation. This requirement should be spelled out in subsequent GALL updates.

3. Conditions that Limit Applicability of GALL Program. Some GALL, Rev. 2 AMPs include certain limiting conditions beyond which the program is not applicable. For example, the screening criteria in GALL AMP XI.M12 is not applicable to ASME SA-351 Grades CF3, CF3A, CF8, CF8A, CF3M, CF3MA, and CF8M materials with ≥0.2 wt% niobium, and the acceptance criteria for performing flaw tolerance evaluations for thermally aged cast austenitic stainless steel (CASS) components by using the fracture toughness of submerged arc welds is not applicable for CASS materials with more than 25% ferrite. Although the GALL AMP includes these limits for the applicability of the program, to ensure applicability the program include a clear statement that applicants referencing this program should provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content.

1. Scope of Program:

1. Age-Related Degradation Process not Addressed. Program element 1 of GALL Rev. 2 AMP XI.M20 ("Open Cycle Cooling Water System") makes no mention of increased roughness at the inner surfaces of open-cycle cooling water system piping due to the formation of tubercles and other ongoing fouling mechanisms. However, this phenomenon was observed in the safety-related auxiliary feedwater supply piping at Ginna, where it impacted the piping internal roughness assumptions used in developing acceptance criteria. While the degradation at Ginna was probably caused by MIC, which is addressed in AMP XI.M20, the effects of the degradation are not explicitly considered. Due to the increased roughness from this aging mechanism, it was determined that the current acceptance criteria established for pressure requirements may not provide sufficient flow in the event of a LOCA. Since this configuration is not tested due to the adverse effects of introducing raw water into the steam generators, additional steps may need to be taken to address this aspect, and GALL AMP XI.M20 may require updating to address this aging mechanism.

   Similarly, during the Ginna audit, an issue was raised about SCC of SS at temperatures less than 60°C (140°F). The site identified multiple examples for thin-walled piping (Schedule 10) which showed sensitization of the heat-affected zone (HAZ) of the weld. During discussions, licensee personnel said writing a new OpE document was not considered, since this issue is specifically addressed in NRC Information Notice 2011-04, "Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Steel Piping in Pressurized

Water Reactors." Consideration should be made to include an AMR line item in GALL to address this issue.

2. Components not Included. Program element 1 of GALL Rev. 2 AMP XI.M9 ("BWR Vessel Internals") makes no mention of an update to the assessment of the core shroud repair clamps to be in compliance with the current Codes and Standards, and include potential effects of plant modifications.

4. Detection of Aging Effects:

1. One-Time Inspection: The EPRI and BWRVIP guidelines cited by GALL, Rev. 2 AMP XI.M2 ("Water Chemistry') and utilized at Ginna, NMP-1, Robinson and most other plants continue to provide the best available guidance on water chemistry control. However, no OpE is available to verify their continued effectiveness for operating periods out to and beyond 60 years. For LTO, consideration should be given to modifying program element 4 of AMP XI.M2 to require a one-time inspection program that samples the entire system prior to entering LTO. This inspection would verify the continued effectiveness of the EPRI water chemistry guidance in controlling corrosion, SCC, and fouling before extending operating periods beyond 60 years. The scope and extent of this inspection program should be based in large part on the plant-specific OpE with respect to corrosion, SCC, and fouling in the systems and components managed by this AMP. Additional periodic inspections may also be required if problems related to water chemistry develop during the period of LTO. This issue is also related to item 3 under the "Program Description" discussion above.

2. Stub Tube Weld Repair: The Ginna plant is working to get NRC approval for a weld repair method of Code Case N-606-1 and BWRVIP-58. The Code Case N-606-1 provides the requirements for performing a DMW repair without preheat and post soak heat treatments on the reactor vessel and control rod drive (CRD) housing interface. For SLR, the detection of aging effects program element may be revised to include the recent guidance for stub tube weld repair activities.

3. Reactor Vessel Surveillance Issues. Ginna indicated that they are expecting their last surveillance capsule to be withdrawn in about 2018 after exposure to the 80-yr-operation fluence level projected for the reactor vessel. It is noted that if Ginna were to continue its operation for the SLR period, it would enter the second license renewal period in 2029, which means that if no additional capsule is reinstituted, Ginna would operate for additional 30 years without a capsule in the reactor vessel. In the broader picture, extended operation beyond 60 years increases the likelihood that a number of licensees will exhaust their supply of surveillance capsules in the reactor vessel. This means that they will increasingly be forced to rely on the alternatives given in GALL AMP XI.M31 ("Reactor Vessel Surveillance"). Currently, program element 4 of GALL XI.M31 recommends that if all surveillance capsules have been removed, a licensee may seek membership in an integrated surveillance program unless the integrated surveillance program does not have surveillance material representative of its limiting beltline materials. Alternatively, the program can propose one of the following: (a) an active surveillance program with reinstituted specimens or (b) an alternative neutron-monitoring program. However, further evaluation may be needed to confirm that one of the foregoing two options is sufficient to adequately manage aging. Both options may possibly be necessary in some cases. In addition, GALL does not provide detailed guidance for an Alternative Neutron Monitoring Program. For SLR, the GALL

options with respect to integrated surveillance programs should be reevaluated, and detailed guidance on an alternative neutron-monitoring program should be provided.

As a part of its reactor vessel surveillance AMP, NMP 1 is participating in an integrated surveillance program (ISP) as described in BWRVIP-116. However, the ISP provisions of BWRVIP-116 and BWRVIP-86-A have recently been merged into BWRVIP-86, Rev. 1, which was approved by the NRC in October 2011 and supersedes BWRVIP-116. During the audit interview, NMP 1 personnel indicated that their ISP is being updated to conform to the new guidance in BWRVIP-86, Rev. 1. This same guidance should be incorporated into updated GALL guidance on an ISP for LTO as a part of program element 4 of GALL AMP XI.M31 ("Reactor Vessel Surveillance").

RNP credits its Reactor Vessel Surveillance Program for aging management of the reactor vessel upper shell, intermediate shell, and lower shell, as well as the reactor vessel inlet and outlet nozzles, for the aging effect and mechanism of irradiation embrittlement resulting in a change of material properties, due to prolonged neutron exposure. RNP performs the projections of changes in material properties, in accordance with NRC RG 1.99, Rev. 2, using both methods allowed: The neutron embrittlement, using chemistry tables, and using the surveillance data, where credible, for which its program is set up to collect data during remainder of the current operating term, and during the PEO

6. <u>Acceptance Criteria</u>:

1. <u>Conditions that Limit Applicability of GALL Program.</u> Some GALL, Rev. 2 AMPs include certain limiting conditions beyond which the program is not applicable. For example, the acceptance criteria for performing flaw tolerance evaluations for thermally aged CASS components by using the fracture toughness of submerged arc welds, is not applicable for CASS materials with more than 25% ferrite. Although the GALL AMP includes these limits for the applicability of the program, to ensure applicability the program include a clear statement that applicants referencing this program should provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content. Furthermore, since the lower bound fracture toughness of thermally aged CASS is the same as that for submerged arc weld, for some analyses such as pump casing, the limiting flaw tolerance analysis should be based on the fracture toughness of thermally-aged weld and not thermally-aged CASS material.

10. <u>Operating Experience</u>:

<u>Effects of Power Uprates.</u> Ginna uprated power by 17% at the beginning of Cycle 33, and, during the subsequent cycle 34, a modest increase in iron transport to the steam generators was noted. At present, only limited OpE (a few operating cycles) is generally available with respect to the possible effects of power uprates on water chemistry control and other plant AMPs. For any plants that have undergone a power uprate prior to PEO, the OpE subsequent to that uprate should be reviewed to verify stable GALL-compliant water chemistry prior to entering into LTO.

RNP implemented power uprates in 1979 and 2002, and, during the audit, RNP was asked about the effects of these power uprates on water chemistry and on iron transport in particular. The 1979 uprate predated the experience of the RNP audit participants, but they stated that the 2002 uprate was accompanied by a reduction in iron transport in the secondary system and

provided auditors documentation from the CDM. This was subsequently verified by data from the RNP CDM on "Feedwater Iron and Copper: Integrated Results from 2000-2012 as Function of % Power."

Impact of Operating Experience on GALL Guidance. For several plant AMPs (e.g., compressed air systems and selective leaching), OpE has been generally favorable. However, it is essential to continue to closely monitor future industry and plant-specific OpE, particularly during the initial 20-year license extension period. In the event of a significant increase in problems, a reevaluation and possible revision of the present AMP XI.M24 may be required before it is applied to LTO.

In a related issue, NUREG/CR-6923 notes that, for piping in a number of systems, the fatigue failure of socket welds is a high susceptibility item, and this is borne out by the OpE at several plants (e.g., Columbia). However, Program Element 10 of AMP XI.M35 ("One-Time Inspection of ASME Code Class 1 Small-Bore Piping') makes no reference to plant-specific OpE on cracking in small-bore piping.

In another example, the OpE at NMP-1 showed that IGSCC cracks were observed in the HAZ of the stub tubes adjacent to the stub-tube-to-housing weld and not in the dissimilar-metal weld (Alloy 182) between the vessel and the stub tube. This information may be significant and should be included in this program element.

3.1.1.2.2. Clarity of the Program Description

Program Description:

1. Program Objective. For several AMPs, the program description section fails to provide a description of the objective of the program, as to what aging effects caused by which aging degradation processes are being managed by the AMP. This is the most important component of the program description and should be clearly described in this section. The program descriptions of most AMPs appear to be incomplete with respect to identifying aging effects and mechanisms. For example, AMP XI.M1 does not indicate what aging effects are being managed by the ISI, or its objective; AMP XI.M19 does not clarify or confirm which aging effects are managed under this AMP (and which are not covered but may be relevant: e.g., cracking due to metal fatigue).

2. Reliance on other AMPs: Several primary AMPs refer to and rely on various other AMPs for certain AMAs. However, generally the AMP description does not clearly define the role of these other AMPs and their interface with the primary AMP. In some LRAs this has resulted in total replacement of primary AMPs with some other AMP(s). For example, GALL AMP XI.M7 does not clearly define its interface and supplementing role with two other AMPs: XI.M2 (Water Chemistry) and XI.M9 (BWR Vessel Internals) related to the IGSCC.

3. Technical Guidance Updates. For a number of the AMPs in GALL Rev. 2, the program description and/or one or more of the program elements cites guidance provided in NRC or industry documents, codes, or standards. Examples include the EPRI and Boiling Water Reactor Vessels and Internals Project (BWRVIP) guidelines referenced in XI.M2 ("Water Chemistry), NRC Generic Letter (GL) 89-13 and its Supplement 1 in XI.M20 ("Open Cycle Cooling Water System"), several of industry standards in XI.M21A ("Closed Treated Water System"), and American Society for Testing and Materials (ASTM) standards in XI.M31

("Reactor Vessel Surveillance"). In most cases, these standards are subject to periodic updates that reflect more recent OpE and research results. In some cases, the guidance in these documents has been superseded by the guidance in other more recent documents (e.g., NUREG-0619 in XI.M5). For example, AMP XI.M11B does not indicate the transient nature of various guidance documents and would need (licensee) to consider various revisions of these as well as the applicable Code Cases. However, the GALL program descriptions are generally silent on the need for licensees to ensure that their AMPs remain in compliance with the most recent NRC-approved guidance, as described on p. XI.3 of GALL, Rev. 2 ("Guidance on Use of Later Editions/Revisions of Various Industry Documents"). This issue should be addressed for LTO. Furthermore, these updates should include the potential effects of plant modification such as EPU and replacement of reactor vessel head or steam generator.

In addition, the GALL AMP XI.M12 endorses 2001 to 2004 editions of the ASME Section XI Code, which requires only surface examination for the pump casing welds, and CC N-481 was annulled on March 28, 2004 because it was incorporated into the ASME Code, but with the exception of the flaw tolerance evaluation, which was deleted. The reason for deleting the flaw tolerance was primarily because the flaw tolerance evaluations performed to date for LRAs were very conservative. The scope of program of GALL AMP XI.M12 does not provide clear guidance for managing the effects of thermal embrittlement for pump casing and valve bodies.

4. <u>ASME Code Edition.</u> As a special case of Item 3 above, the program description and/or one or more of the program elements sometimes fails to address the differences in the inspection requirements between the different editions of the ASME Code Section XI, and between the requirements of the ASME Code Section XI and guidance in other industry documents such as BWRVIP reports, for which the licenses are required to ensure compliance.. Several GALL AMPs cite inspection requirements of ASME Code Section XI, Subsection IWB, Table IWB-2500-1. However, the details of specific requirements of various examination Categories in Table IWB-2500-1 vary depending upon the edition of the Code. For example, the inspection requirements for reactor head closure studs or pump casing between 1995 edition and 2004 edition of the Code have become less stringent. Furthermore, the most common exception to the GALL AMP taken by applicants is related to the edition of the ASME Code Section XI being used by the licensee. Most old plants such as Ginna and NMP-1 continue to follow guidance contained in 1995 edition of the Code with 1996 Addenda. For subsequent license renewal, clearer guidance needs to be provided for licensees currently following Section XI, ISI, in accordance with1995 to 2000 editions of the ASME Code, but plan to follow 2001 or later editions for future inspections. In addition, for BWRs, in some cases the inspection program recommended in 2001 and later editions of the ASME Code, is inconsistent with the staff-approved guidance in BWRVIP-74-A document.

5. <u>Applicant Action Items (AAIs) in NRC SERs.</u> Another special case of Item 3 above relates to the AAIs associated with the NRC SERs of the various industry guidance documents [e.g., various BWRVIP or Materials Reliability Program (MRP) reports] referenced in the GALL AMPs. The guidance of these staff-approved BWRVIP or MRP documents has to be implemented by the respective BWR or PWR licensees. Site procedures require a technical justification to be documented, and the NRC to be notified, for any deviation from the guidelines. Also, as part of the license renewal process, the applicants are required to address these AAIs in Appendix C of its LRAs. Also, as mentioned above, the recommendations of these documents are often not consistent with the requirements of the

edition of the ASME Code Section XI being implemented by the licensee. To ensure compliance with the guidance of these documents, the program description or scope of program of the AMPs that reference such documents should include guidance for the applicant to address all AAIs associated with these documents. Some significant AAIs may be listed in the AMP.

1. <u>Scope of Program</u>:

1. <u>Material of Construction of the Components not Included.</u> The scope of program of several AMPs does not include the material of construction of the components, and their associated welds, that are being managed by the program. This information must be included in the scope of the program, and may be very important regarding the mitigation actions being recommended by the program. For example, decreasing corrosion potential by using HWC in fact increases fatigue crack initiation in austenitic SSs, and HWC may not be effective in decreasing the susceptibility to SCC for some Ni alloy welds (e.g., Alloy 182). In AMP XI.M11B the scope lists susceptible nickel-based components (including their welds), but does not address the scope regarding components fabricated from materials believed to be resistant to PWSCC (e.g., Alloy 690/152/52), and welds (partial or full penetration) which may be mitigated or unmitigated. Also, if buried cast iron pipes are used in some systems, selective leaching of iron due to graphitization of the pipes needs to be addressed.

2. <u>Ambiguities in Program Applicability.</u> Program element 1 of GALL, Rev. 2 AMP XI.M36 ("External Surfaces Monitoring of Mechanical Components") states that "the program may also be credited with managing loss of material from *internal* surfaces of metallic components and with loss of material, cracking, and change in material properties from the *internal* surfaces of polymers, for situations in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program should describe the component internal environment and the credited similar external component environment inspected." The management of loss of material at internal surfaces is also mentioned in program element 4 of this AMP. However, GALL AMP XI.M38 ("Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components") already exists for the management of loss of material from internal surfaces. This wording in the present AMP appears to create possible ambiguity as to which of these two AMPs is to be applied to managing aging degradation at internal surfaces. The wording of program elements 1 and 4 needs to be clarified to clarify program applicability with respect to internal surfaces.

   Another example is that of AMP XI.M7, BWR SCC, which does not include SCC/IGSCC of other safety-related systems [e.g., emergency core cooling system (ECCS), residual heat removal (RHR), and shutdown cooling] and treated water environment (at greater than 60°C) for which AMR items refer to this AMP, and does not clarify the difference in coverage for BWR vessel internals between this AMP and GALL XI.M9 AMP.

2. <u>Preventive Actions</u>:

1. <u>Incomplete Information.</u> The NMP-1 BWR is currently operating under HWC/noble metal chemical addition (NMCA). Zinc feedwater additions are used at NMP-1 for background radiation control. However, while program element 2 of AMP XI.M2 ("Water Chemistry") mentions chemical additive programs such as HWC or NMCA as preventive water chemistry actions, it fails to mention the use of zinc additions to control background radiation.

Another example is that decreasing the corrosion potential in the reactor coolant environment in BWRs by using HWC may not necessarily be beneficial in mitigating cracking. For example, for both SSs and Ni alloys, fatigue crack initiation due to thermal fatigue is, in fact, faster in HWC compared to that in normal water chemistry (NWC). Also, for some Ni alloys and welds, the susceptibility to SCC or IGSCC may not decrease in HWC. Furthermore, in view of such differences in the cracking behavior of some materials, the AMP should clarify that for BWR, the periods of operation under HWC or NWC should be tracked and that any fatigue CUF analyses or fracture mechanics flaw tolerance evaluations performed to justify continued operation or as an option to manage aging effects such as thermal embrittlement of CASS materials, should be periodically updated to ensure their validity during the period of extended operation.

In addition, in GALL AMP XI.M9 "BWR Vessel Internals," the Preventive Actions Program Element states, "the program maintains operating tensile stresses below a threshold limit that precludes IGSCC of X-750 material." However, it does not give any further details regarding any industry document that require the licensees to implement such guidance. Or, if the staff is recommending that the licensees follow this guidance, the AMP does not provide further information that the LRA reviewers should verify that the applicants in its AMP has implemented such guidance.

In another example, the Ginna plant SER stated that it is possible that the studs could have been heat treated to a yield strength value of 150 ksi (1034 MPa) and could be susceptible to SCC. However, program element 2 "preventive actions" of AMP XI.M3 ("Reactor Head Closure Stud Bolting") does not provide any guidance for plants that have SCC susceptible materials (i.e., the material yield strength exceeds 1034 MPa or 150 ksi). Furthermore, this program element does not include the recommendation of RG 1.65 regarding protecting the studs and stud bolt holes in the vessel flange from corrosion and contamination during the venting and filling of the pressure vessel while the head is removed.

3. <u>Parameters Monitored/Inspected</u>:

1. <u>Omission of Relevant NRC Guidance.</u> The Ginna Reactor Vessel Surveillance Program states that the accumulated neutron fluence is monitored from the irradiated material specimens. The program does not clearly address how the licensee's program benchmarks the neutron fluence calculations using the neutron dosimeters. In addition, the program does not clearly describe how it uses the data from the ongoing neutron dosimeter measurements to validate the previous calculations for fluence projections. Program element 3 of GALL, Rev. 2 XI.M31 ("Reactor Vessel Surveillance") recommends the use of neutron dosimeters to benchmark the neutron fluence calculations. NRC RG 1.190 issued in March 2001 provides state-of-the-art calculations and measurement procedures that are acceptable to the NRC staff for determining pressure vessel fluence. However, GALL, Rev. 2 does not refer to RG 1.190. This omission should be corrected before this AMP is applied to LTO.

   In a related issue, the Ginna LRA indicated that when a capsule is removed, the neutron dosimetry data from the withdrawn capsules are evaluated to validate the fluence calculation. During the audit, the licensee indicated that it has no formal procedure for the projection of the fluence; however, the Engineering staff performs the projections using the power data. Furthermore, the licensee (or the program basis document) did not clearly address how frequently the ongoing dosimetry data are used to validate the flux/fluence calculations and projections, especially between the refueling outages when capsules are withdrawn. For

LTO, GALL program element 3 of the GALL AMP XI.M31 ("Reactor Vessel Surveillance") should include the more detailed guidance for the validation of fluence calculations and projections.

4. Detection of Aging Effects:

1. Lack of Clarity: In XI.M7 AMP, "BWR SCC", the program element "detection of aging effects" does not emphasize or even indicate the need for examinations to be qualified for the detection of IGSCC, or that the BWRVIP-75-A based reduction in the inspections is limited only to a subset of welds and only if the effectiveness of underlying mitigation measures is demonstrated that is likely to be plant-specific.

5. Monitoring and Trending:

1. Lack of Guidance or Relevance. The monitoring and trending element of AMP XI.M11B "Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWR only)", essentially includes the routine plant Technical Specification monitoring and flaw evaluation under 10 CFR 50.55a as key activities. From this it is unclear how (and what, if any) flaw evaluation is credited for the monitoring, or how these activities interface or improve the management of cracking and leakage, with specific reference to the PWSCC of reactor coolant pressure boundary (RCPB) components/welds under the AMP XI.M11B.

6. Acceptance Criteria:

1. Lack of Technical Guidance. Two ultrasonic testing (UT) inspections of the fuel oil tanks performed at NMP-1 found regions where the local thickness was less than the acceptance criteria, and engineering evaluations were performed to verify the structural integrity of the tank. The program description for GALL, Rev. 2 XI.M30 ("Fuel Oil Chemistry') states that thickness measurement of tank bottom surfaces is an acceptable method to verify program effectiveness, but it provides no further guidance on acceptance criteria for tank bottom thickness. An industry standard or some other guidance is desirable to address tank bottom thickness determinations and acceptance criteria (program element 6) in more detail.

3.1.1.2.3 Deviation from the GALL Program (Exception/Enhancements)

Program Description:

2. Guidance on Modification of License Renewal Commitments. The GALL, Rev. 2 AMP program descriptions, and GALL in general, provide little guidance on how the applicants/licensees should communicate with the NRC when the license renewal commitments are modified or their implementing schedules are changed. As an example, the Ginna Reactor Vessel Surveillance Program, SER Appendix A includes Commitment 38 under which the licensee agreed to: (1) withdraw surveillance capsule in Spring 2005 and submit test report of results within one year, and (2) withdraw the last surveillance capsule shortly after accumulating fluence equivalent to 80 years of operation. However, Section 5.1.1 of Licensee's program basis document, Rev. 4 (PROGPLAN-20090501-00005) states that Capsule "N" was actually removed in 2008 rather than in the spring of 2005 as stated in commitment (1) above. The Ginna communications with the NRC on their capsule removal schedule do not appear to address this schedule deviation.

3. Consistency of Plant AMPs with GALL. In addition to the most common exception taken by licensees regarding the edition of the ASME Code being implemented by the licensee, both Ginna and NMP-1 took exceptions to and added enhancements to the various GALL AMPs. In general, the exceptions had to do with the performance of specific analyses or test procedures specified in GALL that the applicant consider impractical or ineffective because of plant-specific conditions. For example, NMP-1 takes exception to the GALL XI.M2 Water Chemistry AMP recommendation on the monitoring of hydrogen peroxide, as accurate measurement of this chemical is extremely difficult due to its rapid decomposition in the sample lines. As alternative, they monitor molar ratio of hydrogen to oxygen, consistent with EPRI TR-103515 Rev. 2. Also, NMP-1 took exception to any maintenance recommended in EPRI TR-108147 under the GALL, Rev. 0 AMP XI.M24 ("Compressed Air Monitoring") that is not also endorsed by the equipment manufacturers, and to the pre-service and inservice testing (IST) guidelines of ASME OM-S/G 1998, Part 17, and to certain fuel oil chemistry guidelines under GALL, Rev. 0 XI.M30 ("Fuel Oil Chemistry") that were not applicable to their plant-specific situation. Ginna took exception to GALL, Rev. 0 AMP XI.M21 ("Closed-Cycle Cooling Water System") in that EPRI TR-107396 is not referenced in Ginna procedures, and the only parameters monitored are pH, corrosion inhibitor concentrations, and radioactivity. The Ginna Selective Leaching of Materials Program also took exception to GALL in that hardness testing is not performed as part of the program but will instead be assessed on a component-specific basis.

   In general, enhancements were added to existing plant AMPs to bring them into full conformance with the guidance in GALL, Rev. 0. In a few instances, enhancements were also added to existing plant AMPs to address specific problems encountered during operation. For example, in response to a series of SCC failures in red brass piping components mistakenly installed in this system, NMP-1 added an enhancement to its Compressed Air Monitoring Program to develop and implement activities to address SCC in unannealed red brass piping.

1. Scope of Program:

1. Deviations from GALL Guidance. Program element 1 of XI.M24 ("Compressed Air Monitoring") states that the program manages the aging effects of loss of material due to corrosion in compressed air systems. However, Ginna did not credit this program for monitoring or managing aging effects of components within the scope of license renewal. Instead, the LRA cites the applicant's June 17, 1991, response to GL 88-14, which stated that air-operated valves at Ginna were verified to fail-safe on loss of air, and that therefore the compressed air systems at Ginna did not perform a safety function. During the LTO audit, the licensee stated that aging effects on components within the system were managed through the site's system engineering program. Plant condition reports, including receiver tank wall thickness measurements, indicated that the program was effectively identifying issues. This exception to GALL was approved in the first license renewal review, but the absence of a stand-alone AMP to manage component aging in the compressed air system raises concerns for LTO. Even though the compressed air system may be identified as not directly performing a safety-related function, the compressed air provides the motive power for instruments and active components (some of them safety-related) that may not function properly if nonsafety Group D equipment is contaminated.

2. Updating of Applicant's Program Basis Documentation. Section 4.0 of the Program Basis Document, Rev. 4 for the Ginna Reactor Vessel Surveillance Program states that the

licensee's reactor vessel surveillance program includes the following subprograms: (1) surveillance capsule insertion, withdrawal and evaluation, (2) fluence and uncertainty calculations, (3) monitoring of effective full power years (EFPYs), (4) development of pressure-temperature limit curves, and (5) calculation and monitoring of low-temperature overpressure protection (LTOP). However, no updates have been made to the Program Basis Document since April 2009. Before entering LTO, it is important to verify that the applicant's Program Basis Document is continually being updated in a timely manner.

2. Preventive Actions:

1. Exceptions Related to Operating Experience. Program element 2 of GALL AMP XI.M24 ("Compressed Air Monitoring") specifies maintenance activities to maintain contaminants below levels specified in EPRI TR-108147 and ASME OM-S/G 1998, Part 17 industry standards. However, NMP-1 took exception to any maintenance recommended in EPRI TR-108147 that is not also endorsed by the equipment manufacturers and to the pre-service and IST guidelines of ASME OM-S/G 1998, Part 17. The justification for these exceptions is that there have been no age-related failures in this system under the current program. The acceptability of such exceptions based on an absence of age-related failures should be critically reviewed during the LTO review process.

3. Parameters Monitored/Inspected:

1. Exceptions Related to Operating Experience. The GALL AMP XI.M20 is implemented at Ginna through its "Service Water System Reliability and Optimization Program." As stated in the LRA, this program takes exception to GALL guidance calling for the heat transfer tests on selected small heat exchangers in the open cycle cooling water (OCCW) system, relying instead on periodic cleaning and inspection. However, substantial portions of the internal surfaces of heat exchangers in the OCCW system are often inaccessible for periodic inspections, and heat transfer testing provides the only viable alternative for monitoring heat exchanger performance. Program element 3 of GALL, Rev. 2 AMP XI.M20 ("Open-Cycle Cooling Water System") should be reworded to state that where OpE, particularly during the initial 20-year license extension period, indicates that periodic inspections alone are not adequate to maintain heat exchanger performance, heat transfer testing should be required.

4. Detection of Aging Effects:

1. Verification of LRA Commitments. Program element 4 of GALL, Rev. 2 XI.M41 ("Buried and Underground Piping and Tanks") provides detailed guidance on the directed inspections of buried and underground piping and tanks. According to the Ginna SER Section 3.3.2.3.1, Ginna relies upon its Periodic Surveillance and Preventive Maintenance Program to carry out inspections of underground piping and tanks, and these inspections are performed on an opportunistic basis. No directed periodic inspections are indicated in the Ginna AMP, and this was confirmed by the Ginna program owner during the audit interview. However the NMP-1 LRA does include a commitment to excavate degradation-susceptible areas to perform focused inspections if an opportunistic inspection has not occurred within the past ten years at the time of initial license renewal. The present AMP XI.M41 calls for directed inspections at 10-year intervals, beginning 10 years prior to entering into the initial period of extended operation. Before entering LTO as well as during LTO, it will be necessary to confirm that directed inspections have been performed at the intervals specified in current GALL guidance.

10. <u>Operating Experience</u>:

1. <u>Verification of Compliance with GALL.</u> A review of water chemistry OpE at NMP-1 during the recent audit revealed numerous problems in implementing their HWC, noble metal chemical application, and zinc feedwater additions programs. These problems in controlling levels, which have been compounded by numerous failures of the computer system that controls the hydrogen addition levels, have manifested themselves in the form of rather wide electrochemical potential (ECP) fluctuations and elevated Co-60 levels in the coolant. In addition to the one-time inspection prior to entering into the period of LTO, as recommended under Program Element 4, item 1 above, the pre-LTO audit should verify that the applicant has achieved and is continuing to maintain a stable GALL-compliant water chemistry during the time period leading up to the audit.

   In a related concern, the July-Sept. 2011 System Health Report for the Service Water System at NMP-1 notes that much of the piping is in "a generally degraded condition." As a result, through-wall leaks occur at an "unacceptable" frequency of approximately one per year for 3-inch and smaller diameter piping. Furthermore, the frequency of leaks is increasing. The report also stated that the current practice at NMP is to repair service water piping leaks when they occur in what appears to be a "run-to-failure" strategy. In addition, the NMP-1 Program Basis Document for their closed-cycle cooling water system also reported numerous incidents of pipe leaks. For plants with poor OpE, it is essential to verify their conformance with GALL guidance prior to entering LTO.

   Similarly, at Ginna, while OpE with the plant-specific Periodic Surveillance and Preventive Maintenance Program, the large number of corrective actions that have been initiated since the plant began operation indicates that the mitigation measures to prevent degradation may not be effective or that the frequency for inspection and/or performance monitoring are not adequate. Such plant-specific programs should be reviewed to verify their conformance with the appropriate GALL recommendations.

3.1.2 Generic Analysis of Effectiveness and Implementation of XI.M AMPs

3.1.2.1 Program Strengths of Existing XI.M AMPs

No specific good practice was identified during the review.

3.1.2.2 Program Areas for Further Consideration

8. <u>Confirmation Process</u>:

The GALL Report program elements 8 ("Confirmation Process") and 9 ("Administrative Controls"), deal with the effective implementation of the AMPs. GALL, Rev. 2 states that the confirmation process should ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective. For example, for AMP XI.M2 ("Water Chemistry"), the confirmation process could consist of taking and analyzing additional samples to ensure that the corrective actions were effective in returning the concentrations of contaminants, such as chlorides, fluorides, sulfates, dissolved oxygen, and hydrogen peroxide, to within the acceptable ranges. The confirmation process and administrative controls are to be implemented in accordance with the requirements of 10 CFR Part 50, Appendix B.

The plant audits revealed that both Ginna and NMP-1 maintain program and system health report activities. As noted in the Section 3.0.4 of the Ginna SER, Ginna procedure IP-CAP-1 includes provisions for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving corrective actions, to ensure that effective corrective actions are taken. Potentially adverse trends are also monitored through the action report process. The existence of an adverse trend due to recurring or repetitive adverse conditions will result in the initiation of an action report. Ginna procedure A-1603.6, "Post-Maintenance/Modification Testing," includes provisions for verifying the completion and effectiveness of corrective actions for equipment deficiencies. The procedure also provides guidance for the selection and documentation of post-maintenance or operability tests, provides guidelines to ensure equipment will perform its intended function prior to return to service, and provides guidelines to ensure the original equipment deficiency is corrected and a new deficiency has not been created.

According to Section 3.0.4 of the NMP-1 SER, the focus of the NMP-1 confirmation process is on the follow-up actions that must be taken to verify effective implementation of corrective actions. The measure of effectiveness is in correcting the adverse condition and preventing recurrence of conditions significantly adverse to quality. Plant procedures include provisions for timely evaluation of adverse conditions and implementation of any corrective actions required including root cause determinations and prevention of recurrence. These procedures provide for tracking, coordinating, monitoring, reviewing, verifying, validating, and approving effective corrective actions to ensure that they are taken. The condition report process also monitors for potentially adverse trends. An adverse trend due to recurring adverse conditions will result in a condition report. Aging management activities required for license renewal also would uncover any unacceptable condition due to ineffective corrective action.

The plant audits confirmed that both Ginna and NMP-1 maintain program and system health report activities as a part of the confirmation process. These activities include (1) maintaining an active list of relatively recent plant-specific and industry issues and their dispositions, and (2) conducting periodic assessments of the implementation of the various AMPs, including degradation observed and summaries of overall program status. The results of these activities are used to improve program implementation and effectiveness.

9. <u>Administrative Controls</u>:

The administrative controls for the AMPs provide for a formal review and approval of corrective actions. As stated in the Appendix to GALL, Rev. 2, the license renewal applicant must demonstrate that the effects of aging on structures and components subject to an aging management review will be managed in a manner that is consistent with the CLB of the facility for the period of extended operation. Therefore, those aspects of the AMR process that affect the quality of safety-related structures and components are subject to the quality assurance (QA) requirements of 10 CFR Part 50, Appendix B. For non-safety-related SCs subject to an AMR, the existing 10 CFR Part 50, Appendix B, QA program may also be used to address the elements of corrective actions, confirmation process, and administrative controls as discussed in the GALL appendix. The AMPs applicable to non-safety-related structures and components may instead include alternative means to address corrective actions, confirmation processes, and administrative controls. Such alternate means are subject to review by the NRC on a case-by-case basis.

Ginna stated that the implementing documents are subject to administrative controls, including a formal review and approval process, are implemented in accordance with the requirements of

10 CFR 50, Appendix B, and ANSI N18.7-1976, as committed to in Chapter 17 of the Ginna Station updated final safety analysis report (UFSAR), and that various procedures provide the required controls including a formal review and approval process for procedures and other forms of administrative control documents. Ginna procedures ND-PRO, "Procedures, Instructions and Guidelines," and IP-PRO-3, "Procedure Control," provide guidance on procedures and other administrative control documents. Procedure IP-PRO-3 provides guidance on procedural hierarchy and classification, content and format, and preparation, revision, review, and approval of nuclear directives and all nuclear operating group procedures. Procedure IP-PRO-4, "Procedure Adherence Requirements," establishes procedure usage and adherence requirements. Procedure IP-RDM-3, "Ginna Records," delineates the system for review, submittal, receipt, processing, retrieval, and disposition of Ginna records to meet, as a minimum, the Quality Assurance Program for Station Operation.

The NMP-1 SER simply states that administrative controls provide information on procedures and other forms of administrative control documents as well as guidance on classification documents into document types.

License Renewal Commitments:

Appendix A of the Ginna SER lists a total of 42 license renewal commitments. Of these, 6 are described as having been completed, 3 are superseded by subsequent commitments, 16 are to be completed in 2004-2007, 10 are to be completed prior to entering extended operation in September 2009, 5 are to be completed after 2009, and 2 are ongoing. Similarly, Appendix A of the SER for NMP-1 lists a total of 16 license renewal commitments for Unit 1. Of these, one was described as already completed and the remaining 15 were to be completed prior to entering the period of extended operation in August 2009. However, the AMP effectiveness audits of Ginna and NMP-1 plants could not verify whether all commitments were completed prior to the period of extended operation. For example, all license renewal commitments have not been verified in the Inspection Procedure (IP) 71003 "Post-Approval Site Inspection for License Renewal" reports (ML081650326 and ML091830868 for Ginna Phase I and II, and ML092220005 for NMP-1); only a select sample of commitments were verified.

3.1.3 Effects of Plant Modifications on AMPs

Plant Modifications at Ginna:

Significant modifications, component replacements, and changes in technical specifications at Ginna and their impact on the relevant AMPs include the following:

1. The original Westinghouse Model 44 steam generators, which were placed into service when the plant began operation in 1970, were replaced in June 1996 with an improved design manufactured by Babcock and Wilcox. According to the license renewal SER, Ginna states that these components do not require TLAA evaluation because an explicit fatigue analysis was performed according to the requirements of ASME Section III, Subsection NB-3600, for the 40-year design life of the steam generators. Therefore, these components do not require fatigue monitoring. They are, however, in scope for license renewal and are subject to other AMPs as identified in the LRA.

2. The reactor pressure vessel closure head was replaced during the fall 2003 refueling outage with an improved design that incorporates more corrosion-resistant materials. The control rod drive mechanism (CRDM) penetrations in the replacement head are fabricated of Alloy

690TT with Alloy 52 weld buttering and J-groove welds. Note that these materials/locations, even though considered to be "PWSCC-resistant", are subject to special requirements under XI.M11B AMP for their inspections and monitoring.

3. The original spent fuel racks at Ginna were replaced with a higher density flux-trap design in 1976. This expanded the storage capability from 210 to 595 fuel assemblies. In 1984, the NRC approved the conversion of six flux-trap type racks to high-density, fixed-poison type racks. This further expanded the storage capacity from 595 to 1016 fuel assemblies.

4. Over the years, several sections of the firewater loops have been inspected and replaced with upgraded materials. In 2001, a yard hydrant and connecting piping and a security diesel generator underground fuel oil storage tank were replaced at Ginna. Also, NMP-1 replaced 1.5 in. carbon steel (CS) piping with 2.0 in. SS piping to mitigate corrosion and bio-fouling in the fire water system.

5. In July 2006, the NRC approved a request by Ginna to increase its generating capacity by 16.8% from approximately 525 to 610 megawatts electric. This uprate was implemented at the beginning of operating cycle 33, and, during the subsequent cycle 34, a modest increase in iron transport to the steam generators was noted. The long-term implications of this increased iron transport, while not expected to be significant, are not entirely clear and could contribute to increased FAC.

6. In Appendix D of the LRA, the applicant stated that no technical specification changes had been identified as being necessary to support issuance of the renewed operating licenses for Ginna, per 10 CFR 54.32. However, in a letter dated December 9, 2003, the applicant made a commitment (item 40 in SER Appendix A) to submit a technical specification change by the end of 2004, to incorporate specific particulate testing requirements for diesel generator fuel oil in accordance with the ASTM D2276 standard or its successor. This would replace the use of the "clear and bright" method of the ASTM D4176 standard cited in the Ginna AMP B2.1.16, ("Fuel Oil Chemistry") for determining water and particulate contamination in the diesel fuel oil.

Plant Modifications at NMP-1:

Significant modifications, component replacements, and changes in technical specifications at NMP-1 and their impact on the relevant AMPs include the following:

1. In 1997, the reheater drain line inlet nozzles to the fifth point feedwater heat exchangers were found to be degrading due to flow-accelerated corrosion (FAC). As a corrective measure, FAC-resistant materials were used to replace these piping components, and in 2002 at NMP-2 a second point feedwater heat exchanger low pressure drain line leaked before its scheduled FAC inspection. The degraded low-pressure heater drain lines were replaced with FAC-resistant Fe-Cr-Mo piping material. No impact on the relevant AMPs was noted during the audit.

2. The CRD return line safe-end and the thermal sleeve were replaced in 1978 with modified design to improve resistance to both IGSCC and fatigue. The replacement thermal sleeve material is low-carbon Type 316L SS, and the thermal sleeve is welded to the safe-end with low-carbon Type 308L weld filler. To reduce the probability of fatigue, the thermal sleeve pipe protrudes 7 inches out from the flow shield, which promotes mixing away from the

vessel wall thus preventing thermal cycling at the vessel wall and at the flow shield. No impact on the relevant AMPs was noted during the audit.

3. NMP-1 is replacing six of the eight Boraflex racks with racks made of Boral. The two Boraflex racks remaining in the spent fuel pool will be used only in low flux areas and not in the vicinity of freshly discharged fuel. No impact on the relevant AMPs was noted during the audit.

4. NMP-1 has experienced tube leakage in the BWR isolation condenser and replaced the entire tube bundle with upgraded material in 1997. A keep-fill modification also was installed to eliminate the stressor that caused the tube failures. No impact on the relevant AMPs was noted during the audit.

5. NMP-1 stated in a letter dated November 17, 2005, that new procedures and preventive maintenance tasks for sprinkler head replacements or inspections will be added to its Fire Water System Program to meet National Fire Protection Association (NFPA) guidance NFPA 25. No impact on the relevant AMPs was noted during the audit.

Plant Modifications at RNP:

Significant modifications, component replacements, and changes in technical specifications at NMP-1 and their impact on the relevant mechanical AMPs include the following:

1. RNP implemented power uprates in 1979 and 2002, and, during the audit, RNP was asked about the effects of these power uprates on water chemistry and on iron transport in particular. The 1979 uprate predated the experience of the RNP audit participants, but they stated that the 2002 uprate was accompanied by a reduction in iron transport in the secondary system and provided auditors documentation from the CDM.

2. The HBRSEP ISI program related to its nickel-base components was changed by replacing ultrasonic testing (UT) with the phased-array as the technique used for the reactor vessel loop pipe inspection. The licensee identified some weld indications during the inspection. However, the indications were all embedded (not inside diameter-connected or surface breaking) indications.

3. The RNP water chemistry monitoring program undergoes continuing revisions and has been revised numerous times since license renewal in 2004. The licensee reported during the audit that HBRSEP maintains a Chemistry Data Management System, which is an electronic database used for storing, limit checking, reporting, and trending chemistry analyses.

4. During the audit of the FAC AMP, the NRC staff determined that the HBRSEP recent (Third Quarter 2012) Program Health Report provided an adequate representation of the program's implementation and the status of current issues. The report noted that, based on UT results and trace chromium data collected in refueling outages 26 and 27, there is no wear taking place in the principal high energy systems. The licensee attributed the results to the extensive piping replacement with upgraded materials, major improvements in water chemistry since 1999, and the presence of trace chromium in plant piping.

5. During the audit of the OCCW AMP, the NRC staff noted that the original admiralty brass tubing in the component cooling water heat exchanger had previously been replaced with

90/10 copper nickel tubing in 1990. This tubing material was proactively replaced with AL-6XN during refueling outages 25 and 26, since the old tubing still had acceptable wall thickness. However, an evaluation of the ongoing erosion and corrosion concluded that the heat exchanger tubing would not be acceptable through the end of the PEO. The licensee had also included the inspections of these heat exchangers as part of its One-Time Inspection Program. Also during the audit, the staff discussed with the licensee whether coatings were applied in service water components. The licensee stated that most of the service water carbon steel heat exchanger surfaces have been coated with a polymer ceramic coating to control corrosion, and that no issues regarding degradation of these coatings had been identified. All safety related service water heat exchangers are inspected for degradation per Generic Letter 89-13 and no issue with coated or uncoated surfaces have been identified.

Changes in Ginna AMPs in Response to Regulatory Guidance:

Changes in the LRA and the AMPs by Ginna in response to regulatory guidance include the following:

1. Section C.8 of RG 1.13 states that a seismic Category 1 makeup system should be provided to add coolant to the spent fuel storage pool. It also states that appropriate redundancy or a backup system for filling the pool from a reliable source, such as a lake, river, or onsite seismic Category 1 water-storage facility, should be provided. The Ginna LRA indicated that the refueling water purification pump and associated valves and piping in the flow path from the spent fuel pool to the refueling water storage tank are indicated to be outside the scope of license renewal. The flowpaths from the alternate makeup sources are also not shown as subject to an AMR. Ginna subsequently agreed to add these components to the scope of license renewal.

2. In the Ginna LRA, the Fire Protection System fire service water booster pump, piping, and valves were not initially included in scope of license renewal. This exclusion was based upon Ginna's position that these components are not required by the CLB to achieve compliance with the requirements of Branch Technical Position 9.5-1. The NRC staff noted that the NFPA 20 "Standard for the Installation of Centrifugal Fire Pumps," which is endorsed by Section 6.b.6 of BTP 9.5-1, was cited by the Ginna UFSAR as the licensing basis for the plant. Based upon this standard, it was determined that the jockey pump and storage tank and their associated piping and valves perform a pressure maintenance function, as stated in the UFSAR, which protects the large fire pumps from damage during low-flow, high-pressure operation and is an essential part of the fire water system. Ginna agreed to modify the LRA to indicate that these components were in the scope of license renewal and subject to an AMR.

3. The AMP implemented by Ginna, and by most of the license renewal applicants in general, have been consistent with the GALL AMP XI.M19. Therefore, there have been no industry-proposed exceptions or enhancements to this AMP. Staff's review of the Ginna's implementation of AMP XI.M19 "Steam Generators" indicated that the steam generator (SG) plant procedures may include exemptions from 10 CFR 50.59 requirements, suggesting the need for license renewal guidance documents to further clarify that the aging management programs and activities summarized in the UFSAR are, in fact, subject to the requirements of 10 CFR Part 50.59.

Changes in NMP AMPs in Response to Regulatory Guidance:

Changes in the LRA and the AMPs by NMP-1 in response to regulatory guidance include the following:

1. As a part of its reactor vessel surveillance AMP, NMP 1 is participating in an ISP as described in BWRVIP-116. However, the ISP provisions of BWRVIP-116 and BWRVIP-86-A have recently been merged into BWRVIP-86, Rev. 1, which was approved by the NRC in October 2011 and supersedes BWRVIP-116. During the audit interview, NMP 1 personnel indicated that their ISP is being updated to conform to the new guidance in BWRVIP-86, Rev. 1.

Changes in RNP AMPs in Response to Regulatory Guidance:

Changes in the LRA and the AMPs by RNP in response to regulatory guidance include the following:

1. The licensee indicated that the current HBRSEP Systems Monitoring Program is significantly improved from the program that HBRSEP had in place in the 1990's prior to license renewal. In particular, the program has improved in terms of program procedures, record-keeping, and data monitoring and trending. Also, the licensee maintains a comprehensive electronic database to track component conditions with time.

2. RNP was very responsive to NRC guidance (RIS 2011-07) on XI.M16A (PWR Internals). RNP developed a new program that is credited for managing the following aging degradation effects and the associated mechanisms on the intended function of the reactor internal components through inspection and condition monitoring activities in accordance with the augmented requirements defined under industry directives as contained in MRP-227-A and ASME Section XI: (a) Cracking due to SCC, IASCC, and fatigue; (b) loss of material due to wear; (c) reduced fracture toughness due to thermal aging embrittlement and irradiation embrittlement; (d) dimensional change and distortion and possible cracking due to void swelling, and (e) loss of preload due to thermal and irradiation-enhanced stress relaxation (or irradiation-enhanced creep), which may eventually cause subsequent degradation by fatigue and wear, and result in cracking. Where applicable, credit is taken for existing programs such as water chemistry, inspections in accordance with ASME Section XI ISI, thimble tube inspections, and mitigation activities.

3.2 AMPs for Structural Systems (XI.S AMPs)

The 8 AMPs numbered XI.S1 through XI.S8 in Chapter XI of the GALL Report, one AMP numbered X.S1 in Chapter X of the report, and two plant-specific AMPs, for structures are discussed in this section. The format for the evaluation of these AMPs is the same as that of the AMPs for mechanical systems.

3.2.1 Generic Analysis of Adequacy of the GALL Rev 2. XI.S AMPs

3.2.1.1 Program Strengths of Existing XI.S AMPs

No program strength was identified in this review that relates to adequacy of the GALL Rev. 2 program descriptions of the AMPs for structures.

3.2.1.2 Program Areas for Further Consideration

1. Program Objective. For several AMPs, the program description section fails to provide a clear description of the objective of the program, environments, and aging effects and aging mechanisms caused by the environments. This is the most important component of the program description and should be clearly described in this section. For example, one of the main objectives of XI.S1 ("ASME Section XI, Subsection IWE") is aging management of the torus shell of MARK I steel containments, which has severe corrosion problems. The CS torus interior may be uncoated and susceptible to corrosion in a moist environment. It is important to address this environment and identify the associated aging effects and aging mechanisms.

   GALL Rev. 2 Not Used. Ginna, NMP-1, and Robinson structural AMPs were based on GALL Rev. 0. and do not include augmentations found in GALL Rev. 2. For example, AMP XI.S3 ("ASME Section XI, Subsection IWF"), has been augmented to include the monitoring of high-strength structural bolting to prevent or minimize loss of bolting preload and cracking. This augmentation is not implemented at Ginna or NMP-1. The GALL Program Description should address the need to implement such augmentations in AMPs that were developed based on previous GALL versions.

2. Interface Between GALL AMPs. In the GALL Report, there are examples of aging effects for specific SSCs that are co-managed by another AMP. However, the Program Description of the other AMP fails to mention those SSC. For example, the GALL Program Description of AMP XI.S5 ("Masonry Walls") states that aging effects on masonry walls that are considered to be fire barriers are also managed by AMP XI.M26, ("Fire Protection"). However, the Program Description and Scope of Program of AMP XI.M26 does not mention fire-barrier masonry walls.

3. Technical Guidance Updates. The program description often cites guidance provided in NRC or industry documents, codes, or standards. In most cases, these standards are subject to periodic updates that reflect more recent OpE and research results. For example, RG 1.127, Rev. I is cited in the Program Description of AMP XI.S7. Since the last revision of RG 1.127, several changes have been made to dam safety laws and to the requirements imposed on safety programs. The draft version of RG 1.127, Rev. 2 (NRC Draft Regulatory Guide, DG-1245) reflects current NRC positions and expectations for inservice inspection programs and provides a summary of the principal causes of dam failures and suggestions

for preventive measures. The example demonstrates the need to update the technical guidance cited in the program description.

4. ASME Code Edition. The inservice inspection requirements of AMPs XI.S1 (" ASME Section XI, Subsection IWE"), XI. S2 ("ASME Section XI, Subsection IWL"), and XI S3 ("ASME Section XI, Subsection IWF") are based on the 2004 edition of the ASME Code as stated in the program description. The Federal Register (Vol. 76, No. 119, June 21, 2011) states that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL are acceptable for adoption as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report. Based on this statement, the program descriptions of AMPs XI.S1, XI.S2, and XI S3 need to be updated to include the requirements of the 2007 edition of ASME Code.

   In another example, the Program Description of AMP XI.S1 states that the program is augmented to require surface examination of DMWs of vent line bellows in accordance with examination Category E-F, as specified in the 1992 Edition of the ASME Code, Section XI, Subsection IWE. However, as stated above, the 2007 edition of ASME code is acceptable to be adopted as AMPs for license renewal. The 1992 Edition of the ASME code therefore appears to be outdated.

1. Scope of Program:

1. Incomplete Information. Some AMPs do not contain adequate descriptions on the specific structures and components subject to an aging management review. For example, AMP XI.S4 ("10 CFR 50, Appendix J") simply states that scope of the containment leakage rate test (LRT) program includes all containment boundary pressure-retaining components. It does not specifically identify these components, which could include containment structure, all penetrations, equipment hatches, personnel air locks, and containment isolation valves.

   In another example, the scope of GALL AMP XI.S7 ("RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants") does not include specifically flood protection walls and gates, which are crucial water-control structures.

2. Inclusion of Additional SSCs Needed. Based on the AMPs implemented at Ginna and NMP-1, additional SSCs may be included in the scope of GALL AMP XI.S2. For example, the scope may be expanded to include containment penetration cooling systems and the reactor compartment cooling system, which are in the scope in the Ginna's license renewal. These two systems maintain temperatures in the containment concrete below threshold. Another example is the inclusion of aging management measures for flood protection walls and gates in AMP XI.S6 ("Structures Monitoring") and AMP XI.S7 ("RG 1.127, Inspection of Water Control Structures Associated with Nuclear Power Plants").

   For several AMPs, the scope of program lacks an overall description of the SSCs that are covered in the AMP. For example, the GALL AMP XI.S4 (10 CFR 50 Appendix J) does not state clearly that a typical reactor containment structure consists of over one hundred electrical and mechanical penetrations, two or three equipment hatches, and personal air locks. The containment can be subjected to various types of aging degradation, depending on the inherent characteristics of the materials, the fabrication processes, and the

construction methods. The rate and extent of the degradation are influenced by sustained environmental conditions such as temperature, humidity, water leakage, and borated water spills. The objective of Appendix J is to identify and quantify leakage through the primary containment as well as systems and components that penetrate primary containment, to ensure containment will perform its isolation safety function.

GALL Version 2 Not Used. Ginna and NMP-1 structural AMPs were based on GALL Rev, 0. Augmentations in GALL Rev. 2 were not implemented in the AMPs. As stated above with respect to the Program Description, AMPXI.S3 has been augmented to include monitoring of high-strength structural bolting to prevent or minimize loss of bolting preload and cracking of high-strength bolting. In another example, AMP XI S7has been augmented to require monitoring of wooden components for loss of material and change in material properties.

3. Components in Inaccessible Areas Not Included. Some AMPs do not include the components in inaccessible areas. For example, there are inaccessible items exempted from ASME Section XI, Subsection IWF. These items include those portions of supports that are inaccessible by being encased in concrete, buried underground, or encapsulated by guard pipe. These inaccessible items are not mentioned in AMP XI.S3.

4. Age-Related Degradation Process Not Addressed. The aging effects/mechanisms due to delayed ettringite formation (DEF) in concrete are not addressed in AMP XI.S2 ("ASME Section XI, Subsection IWL, XI.S6 Structure Monitoring"), and AMP XI.S7 ("RG 1.127, Inspection of Water-Cooled Structures Associated with Nuclear Power Plants"). If concrete is exposed to substantial amounts of water for extended periods, DEF may occur, leading to volume expansion and the destructive expansive forces crack the concrete. DEF was first reported in heat-cured railway ties in Germany in the early 1980s. Since then, several other countries including the U.S. have reported DEF problems in concrete structures (DOT News Letter, July 2004).

2. Preventive Actions:

1. Incomplete Information. Quite often, no preventives actions are recommended in the GALL, simply because the AMP is a monitoring program. However, there are certain measures that can prevent or mitigate corrosion such as the painting of component surfaces. Even though painting is not in scope of license renewal, it can be recommended generically as a preventive action for those structural AMPs that are primarily monitoring programs.

   In another example, NMP-1 has a plant-specific Drywell Shell Corrosion Monitoring Program that measures and monitors the shell wall thickness. However, NMP-1 also performs cleaning of drywell area coolers, which contributes to corrosion and drywell wall thinning. Periodic cleaning of the coolers inside the steel and concrete containments can be recommended as preventive action in structural AMPs such as XI.S1 and XI.S2.

3. Parameters Monitored or Inspected:

1. Lack of Detailed Information. GALL program element of XI. S1 states that "Painted or coated surfaces are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress." The statement does not make clear whether these examinations include coatings inside the torus shell. This statement could be reworded to say "Painted or

coated surfaces, including paints inside torus shell, are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress."

2. Parameters Monitored/Inspected not Adequate. Additional parameters for monitoring and inspection are needed in this program element. For example, this program element in AMP XI.S4 states that the parameters to be monitored are leakage rates through containment shells, containment liners, and associated welds, penetrations, fittings, and other access openings. Because the AMP also relies on IWE and IWL inspections, aging effects such as loss of material due to corrosion, SCC, loss of sealing, elastomer degradation, and loss of leak lightness due to material degradation should also be included in this program element.

   In another example, AMP XIS5 ("Masonry Walls") needs to add additional parameters to be monitored or inspected, such as notable deflection or distortion, loose bolts, and corrosion and degradation of structural steel coatings. AMP XI.S6 should add parameters including ground water leakage, building settlement and differential settlement, seismic gaps between buildings, and displacements of sliding surfaces.

4. Detection of Aging Effects:

1. Inadequacy Measurement Locations. The UT measurements of NMP-1 torus wall are performed on the pre-selected areas of the torus with the known thinnest average wall thickness. This may overlook unexpected corrosion in some other areas. Thus, the GALL XI.S1 ("ASME IWE Program") should recommend that UT thickness measurements also be performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell and aging effects can be detected in a timely manner.

2. Detection of Aging Effects due to DEF (Delayed Ettringite Formation). The combination of aging effects/mechanisms due to DEF is not included in the AMPs of GALL Rev.2 related to concrete structures. Excessive heat curing that decomposes the ettringite in Portland cement during the hydration process causes this degradation. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion and cracking. The AMPs includes XI.S2 ("ASME Section XI, Subsection IWL"), XI.S6 ("Structure Monitoring"), and XI.S7 ("RG 1.127, Inspection of Water-Cooled Structures Associated with Nuclear Power Plants").

3. Impact of EPU. Increasing temperatures and loadings on SSCs and equipment and piping supports due to EPU may result in a need for more frequent inspections in the IWF Program to ensure that aging effects are detected in a timely manner. This GALL program element needs to add a statement to reflect this need. In as an example, the test pressure for containment leak rate testing under AMP XI.S4 ("10 CFR 50 Appendix J") was increased at NMP-2 as a result of EPU modification.

   This program element also needs to take into consideration the effects of EPU to ensure that the qualification test methods used in AMP XI.S8 ("Protective Coating Monitoring and Maintenance") continue to be effective.

4. Inspection after Seismic Event and other Natural Hazard Events. NMP-1 performs inspections of masonry walls after seismic events. This ensures that the original evaluation basis is not invalidated and seismic margins of the masonry walls are not eroded. This GALL program element does not address inspections of SCCs after seismic and other natural hazard events.

5. Monitoring and Trending:

Incomplete Information. In some cases, this GALL program element does not provide sufficient information and guidance. For example, trending for AMP XI.4 ("10 CFR 50, Appendix J") is important, as stated in 10 CFR Part 50 Appendix J: "The test results must be compared with previous results to examine the performance history of the overall containment system to limit leakage." This should be stated in Program Element 5 of this AMP. In another example, this GALL program element in AMP XI. 5 ("Masonry Walls") states that trending is not required. However, NMP-1 compares older checklists for masonry walls to recent checklists for trending, as well as to the original evaluation basis developed during the resolution of IEB 80-11.

Ground Water Leakage Trending. Ground water penetration and leakage have occurred in various NPP structures and can become more severe as plants age. This GALL program element does not address monitoring and trending the amount of water leaking into structures over a given time period.

6. Acceptance Criteria:

1. Lack of Technical Guidance. Some AMPs lack technical guidance under this program element. For example, the acceptance criteria for AMP XI.S5 ("Masonry Walls") only states that for each masonry wall, the extent of observed shrinkage and/or separation and cracking of masonry may not invalidate the evaluation basis or impact the wall's intended function. Further evaluation is conducted if the extent of cracking and loss of material is sufficient to impact the intended function of the wall or invalidate its evaluation basis. Technical guidance on acceptance criteria should be provided clearly. As an example, the criteria used a NMP-1 include the following:

   - For masonry wall severing as fire barrier, any missing blocks, mortar, or cracks in the wall which cause a clear opening within the wall are considered unacceptable and require corrective action.

   - The applicable calculation (i.e., evaluation basis) for each masonry wall should be kept in record. If degradation of the wall or associated steel is judged significant or of concern then a review of the respective calculation and further evaluation is performed to determine the effect on the evaluation basis.

   - Resolution of "use-as-is" or "acceptable with deficiencies" for degradation appears "unacceptable" and must be technically justified and approved by engineering analysis. If more sophisticated analysis methods, such as finite element analysis, are used in the engineering analysis, it would be considered as a new evaluation basis against seismic loads.

10. Operating Experience:

1. Inclusion of Latest NRC Information Notices and other Recent NRC Documents. NRC Information Notices provide useful information on the plant OpE and events. For GALL in subsequent license review, the GALL program element and applicant's LRA should include additional NRC Information Notices.

For example, NRC Information Notice (IN) 2011-15, "Steel Containment Degradation and Associated License Renewal Aging Management Issues" describes recent issues identified concerning degradation of steel containments that could impact aging management of containment structures during the period of extended operation. NRC IN 2010-12, "Containment Liner Corrosion" addresses corrosion of steel containment liners at the Beaver Valley, Salem, and Brunswick plants. IN 2010-14 addresses containment concrete surface condition examination frequency and acceptance. IN 2009-04, "Age-Related Constant Support Degradation" describes deviations in the supporting forces due to wear on the linkage and increased friction between the various moving parts and joints within the constant support and is related to XI S3 ASME IWF program.

2. Operating Experience of Ground Water Leakage not Addressed: This affects several AMPs, including XI.S2, XI.S6, and XI.S7, where this program element does not address OpE related to ground water leakage/penetration into structures. An example of such OpE is provided by an NRC inspection report from 2011, which found that ground water penetration to underground electric tunnel at Seabrook plant caused the concrete to lose more than 20 percent of its strength due to sulfate attack. Another example is the following OpE is found in Section 3.0.3.2.21 of the NRC SER for NMP-1 plant, which noted the following:

   - Minor cracking in various concrete structures and slight (but stable) ground water leaks in some tunnels

   - Several condition reports (CRs) have identified minor cracking in concrete structures including the service water pipe tunnel, which is susceptible to small wall cracks allowing leakage of ground water.

   - Groundwater also has entered switchgear building, service water tunnels, and the radwaste building of below grade exterior walls.

3.2.2 Generic Analysis of Effectiveness and Implementation of XI.S AMPs

3.2.2.1 Program Strengths of Existing XI.S AMPs

1. Quarterly Trending Report. Ginna has quarterly trending report. This quarterly trending is considered to be a good practice, since it provides a basis for continued improvement of program effectiveness and should be considered for inclusion as a part of program element 5 in the applicable GALL structure AMPs.

2. Photographing the Entire Containment Surfaces: Ginna photographed the whole containment surface as a baseline record prior to the PEO in 2002-2003. This is considered as good practice and should be implemented at other plants.

3. Cleaning and Painting Anchor Bolts: Ginna cleaned and painted all component anchor bolts located in the sub-basement to stop corrosion. This is considered as a good practice and should be recommended at other plants.

4. Inspection after Seismic Event: NMP-1 requires that following an unusual event such as earthquake, tornado, or flooding, an initial inspection should be conducted in assessing conditions of the affected SSCs. This is considered good practice and is recommended for subsequent license renewal.

5. Performing Structural Integrity Tests (SITs): Ginna commits to perform two SITs during the PEO (SER commitment item 27) to verify performance of the lower portion of the prestress containment. The SIT tests would verify the behavior of the containment in the lower portion of the containment and is considered as "strength" of the Ginna's Tendon Prestressing AMP.

6. Cleaning the Containment Area Coolers: NMP-1 performs cleaning of the area coolers in the maintenance procedure that could provide prevention corrosion for the dry well shell near and underneath the coolers. This is considered as good practice.

3.2.2.2 Program Areas for Further Consideration

8. Confirmation Process:

See Section 3.1.2.2.

9. Administrative Controls:

See Section 3.1.2.2.

License Renewal Commitments:

This section discusses the license renewal commitments in Appendix A of Ginna and NMP-1 SERs. Based on the review, it appears that all the commitments in Ginna and NNP-1 have been completed or incorporated in the Plant Technical Specifications. In the current report, some of the commitments have been recommended for inclusion in the GALL AMPs for subsequent license renewal. For example, inspection of wooden power poles and transmission towers, regularly scheduled ground water monitoring, and increasing inspection frequency of un-reinforced and un-braced masonry walls have been recommended.

3.2.3 Effects of Plant Modifications on XI.S AMPs

Plant Modifications at Ginna:

Significant structural modifications, component replacements, and changes in technical specifications at Ginna and their impact on the relevant AMPs include the following:

1. In July 2006, NRC approved a request by Ginna to increase its generating capacity by 16.8% from approximately 525 to 610 megawatts electric. No structural AMPs at Ginna were affected by the power uprate. However, on the plant audit of NMP-1, engineers at NMP-1 indicated that the test pressures of the NMP-2 containment leak rate test have been increased due to the power uprate of NMP-2.

2. High strength bolts for the nuclear steam supply system (NSSS) at Ginna were replaced due to potential or actual stress corrosion cracking. Ginna used a 10 CFR 50.59 approach to eliminate a license renewal commitment to perform UT examination of high strength bolts as recommend in GALL Rev. 2. The new bolts were tightened using a standard stud wrench, which eliminated the excessively high pre-load. Inspections during subsequent outages revealed no evidence of bolt distress.

Plant Modifications at NMP-1:

Significant structural modifications, component replacements, and changes in technical specifications at NMP-1 and their impact on the relevant AMPs include the following:

1. The licensee has recoated the affected areas of the drywell shell in NMP-1 in 2011 to stop corrosion of the drywell shell that was caused by aggressive chemical used to clean coils of the area coolers. NMP-1 has decided to stop monitoring the drywell thickness in the Drywell Supplement Inspection Program.

Plant Modifications at RNP:

Significant structural modifications, component replacements, and changes in technical specifications at RNP and their impact on the relevant structural AMPs include the following:

1. RNP removed and replaced the existing insulation containing chloride with the chloride-free insulations. Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the coating degradation and subsequent corrosion of the liner. This is considered a good practice and may be included in the preventive actions program element AMP XI.S1.

Changes in XI.S AMPs in Response to Guidance and Operating Experience:

Changes in the Ginna and NMP-1 LRAs and the AMPs in response to regulatory guidance, 10 CFR 50.59, OpE, and other NRC requirements or code changes are reviewed in this section. This review noted that there are several cases of AMP changes made through 10 CFR 50.59 but very few changes in response to OpE. For the subsequent license review, GALL should add more OpE, especially those from recent years as described in the NRC Information Notices such as ground water leakage/penetration (see program Element 10, “Operating Experience” in section 3.2.1.2).

The ground water as well as Lake Robinson is aggressive (low pH value). The XI.S2 AMP includes a task that uses inspection results of submerged portions of concrete structures throughout the site such as the intake structure, as a leading indicator. Engineering evaluation will be performed to evaluate the potential degradation for the below-grade containment concrete exposed to aggressive ground water based on the leading indicator. Establishing a leading indicator based on inspection results of the submerged structures through the site for potential degradation of other below-grade structures in the site is considered as a good practice.

3.3 AMPs for Electrical Systems (XI.E AMPs)

The 6 AMPs numbered XI.E1 through XI.E6 in Chapter XI of the GALL Report and one AMP numbered X.E1 in Chapter X are discussed as a group in this section. The program description of the AMP summarizes, in no more than a few paragraphs, the aging effect to be managed, the aging mechanism(s) responsible for this effect, the overall approach proposed to manage this aging effect, and the technical basis for this approach. In general, the program descriptions provided in GALL, Rev. 2, as well as those in the Ginna and NMP-1 AMPS for electrical systems met these objectives. Furthermore, the GALL Report, Rev. 2, states that this program element should include the specific structures and components that are subject to an aging management review.

Over the course of the AMP reviews and audits, the following strengths (or good practices) and areas that may require further considerations or enhancements were identified. As discussed above these are divided into two sections, (a) adequacy of the GALL, Rev. 2, program description and (b) effectiveness and implementation of the AMP. A third section discusses briefly the effects of plant modifications such as EPU or replacement of reactor vessel head or steam generator, on the AMPs. The adequacy of the program is further divided into three subsections, (i) management activities of the AMP, (ii) clarity of the program description, and (iii) deviations from the GALL program (exceptions/enhancements). Each of these subsections includes an evaluation of program description, program elements 1 through 7, and OpE. The remaining two program elements, licensee's commitments, and plant-specific follow-up activities by the licensees to confirm that the corrective actions have been completed, a root cause determination was performed, and recurrence of the aging degradation effect will be prevented are discussed in the second section on effectiveness and implementation of the AMP.

3.3.1 Generic Analysis of Adequacy of the GALL Rev 2. Program Descriptions

3.3.1.1 Program Strengths of Existing XI.E AMPs

No program strength was identified in this review that relates to adequacy of the GALL Rev. 2 program descriptions of the AMPs for electrical systems. Based on the staff effectiveness audit of AMP XI.E4 at RNP, the applicant's counterpart to XI.E4 is capable of inspecting the material and components internal to in-scope non-segregated bus duct. Visual inspection should be included as parts of inspection of bolted connection covered by heat shrink as well as uncovered bolted connections. The visual inspection could be used to detect broken washers, as well as corrosion of bolted connections. It might be advisable before going into SLR, that all bolted connections should be inspected, instead of a sample of bolted connections. Visual inspection should be considered for uncovered bolted connection, as well as resistance measurement or thermography. If thermography is considered, a window on the bus duct should be installed, because the cover of bus duct will mask any heat rise.

3.3.1.2 Program Areas for Further Consideration

Management Activities of the AMP

<u>Program Description</u>:

Most AMPs in the GALL Report provide a comprehensive management program that typically consists of two or more AMAs such as condition monitoring, prevention or mitigation, or

performance monitoring. For a number of the electrical AMPs, the program description section either fails to provide a clear description of the AMAs being recommended and their significance in managing the aging effects.

1. <u>Scope of Program</u>:

The objective of AMP XI.E3 is to provide reasonable assurance that the intended functions of inaccessible or underground power cables that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to wetting or submergence are maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a condition monitoring program. However, periodic actions are taken to prevent inaccessible cables from being exposed to significant moisture, such as identifying and inspecting in-scope accessible cable conduit ends and cable manholes for water collection, and draining the water, as needed.

Consideration should be given to whether future versions of XI.E3 scope should include lower voltages (0 to 1000 V power cable). The scope of XI.E3 is currently only inaccessible power cables equal to or greater than 400V. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E3 may need to further review items identified.

2. <u>Preventive Action</u>:

No further review items were identified in the electrical AMPs reviewed. As stated in GALL Rev. 2, most of these are condition monitoring programs and no actions are taken as part of these programs to prevent or mitigate aging degradation.

3. <u>Parameters Monitored/Inspected</u>:

The objective of AMP XI.E1 is to provide reasonable assurance that the intended function of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse local environments caused by heat, radiation or moisture will be maintained consistent with the current licensing basis through the period of extended operation. No further review items were identified.

The definition of accessible may need further clarification. One suggestion was to consider a redefinition of accessible cables and connections in the context of accessible for walkdowns.

AMP XI.E1 depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. (G3, N1) GALL states for plants or areas that have no accessible cable for visual inspection, this program would not apply and cables in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated.

4. Detection of Aging Effects:

Generically, for the electrical AMPs, the definition of accessible may need further clarification. GALL Rev. 2 states for plants or areas that have no accessible cable for visual inspection, this program would not apply and cables in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated.

5. Monitoring and Trending:

No further review items were identified in the electrical AMPs reviewed.

6. Acceptance Criteria:

Generically, for the electrical AMPs, the definition of accessible may need further clarification. GALL Rev. 2 states for plants or areas that have no accessible cable for visual inspection, this program would not apply and cable in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated.

7. Corrective Actions:

No further review items were identified in the electrical AMPs reviewed.

8. Confirmation Process:

No further review items were identified in the electrical AMPs reviewed.

9. Administrative Controls:

No further review items were identified in the electrical AMPs reviewed.

10. Operating Experience:

No further review items were identified in the electrical AMPs reviewed.

3.3.2 Generic Analysis of Effectiveness and Implementation of XI.E AMPs

The GALL Report program elements 8 ("Confirmation Process") and 9 ("Administrative Controls"), deal with the effective implementation of the AMPs. GALL, Rev. 2 states that the confirmation process should ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective. However in the electrical AMPS, there are no preventive actions considered since they are all identified as being condition monitoring programs.

3.3.3 Effects of Plant Modifications on XI.E AMPs

Applicants made plant modifications in response to XI.E2 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits.

Table 3.1 Relationship between GALL AMPs and those Implemented at the Audited Plants

GALL AMP ID	GALL AMP	Ginna (WEST 2LP PWR) NUREG-1786 AMP Reviewed	NMP-1 (Mark-I BWR) NUREG-1900 AMP Reviewed	RNP (PWR) NUREG-1785 AMP Reviewed
AMPS for Mechanical Systems				
X.M1	Fatigue Monitoring (TLAA)	Fatigue Monitoring (B3.2)	Fatigue Monitoring	Metal Fatigue of Reactor Coolant Pressure Boundary (B3.19)
XI.M1	ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD	ASME Section XI, Subsections IWB, IWC, and IWD Inservice Inspection (B2.1.2)	ASME Section XI Inservice Inspection (IWB,IWC, IWD) (B2.1.1)	ASME Section XI, Subsections IWB, IWC, and IWD Inservice Inspection (B2.1.)
XI.M2	Water Chemistry	Water Chemistry Control (B2.1.37)	Water Chemistry Control (B2.1.2)	Water Chemistry (B2.2)
XI.M3	Reactor Head Closure Stud Bolting	Reactor Head Closure Studs (B2.1.25)	Reactor Head Closure Studs Program (B2.1.3)	Reactor Head Closure Studs (B2.3)
XI.M4	BWR Vessel ID Attachment Welds	*N/A — AMP exclusively for BWRs*	BWR Vessel ID Attachment Welds Program (B2.1.4)	*N/A — AMP exclusively for BWRs*
XI.M5	BWR Feedwater Nozzle	*N/A — AMP exclusively for BWRs*	BWR Feedwater Nozzle Program (B2.1.5)	*N/A — AMP exclusively for BWRs*
XI.M6	BWR Control Rod Drive Return Line Nozzle	*N/A — AMP exclusively for BWRs*	BWR Rod Control Drive Return Line Nozzle Program (B2.1.37)	*N/A — AMP exclusively for BWRs*
XI.M7	BWR Stress Corrosion Cracking	*N/A — AMP exclusively for BWRs*	BWR Stress Corrosion Cracking Program (B2.1.6)	*N/A — AMP exclusively for BWRs*
XI.M8	BWR Penetrations	*N/A — AMP exclusively for BWRs*	BWR Penetrations Program (B2.1.7)	*N/A — AMP exclusively for BWRs*
XI.M9	BWR Vessel Internals	*N/A — AMP exclusively for BWRs*	BWR Vessels Internals Program (B2.1.8)	*N/A — AMP exclusively for BWRs*
XI.M10	Boric Acid Corrosion	Boric Acid Corrosion (B2.1.6)	*N/A — AMP exclusively for PWRs*	Boric Acid Corrosion (B3.2)
XI.M11B	Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWR Only)	Reactor Vessel Head Penetration Inspection (B2.1.26)	*N/A — AMP exclusively for PWRs*	Nickel-alloy Nozzles and Penetrations (B4.1)

Table 3.1 Relationship between GALL AMPs and those Implemented at the Audited Plants

GALL AMP ID	GALL AMP	Ginna (WEST 2LP PWR) NUREG-1786 AMP Reviewed	NMP-1 (Mark-I BWR) NUREG-1900 AMP Reviewed	RNP (PWR) NUREG-1785 AMP Reviewed
XI.M12	Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)	Thermal Aging Embrittlement of CASS (B2.1.34)	*N/A — no CASS piping at NMP-1*	Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)(B4.2)
XI.M13	Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel (CASS) – *retired after GALL Rev. 1.*	*N/A — see AMP XI.M12*	*N/A — see AMP XI.M12*	*N/A — see AMP XI.M12*
XI.M14	Loose Part Monitoring – *retired after GALL Rev. 1.*	Loose Parts Monitoring (B2.1.19)	*N/A — AMP not implemented at NMP-1*	*N/A — AMP not implemented at RNP*
XI.M15	Neutron Noise Monitoring – *retired after GALL Rev. 1.*	Neutron Noise Monitoring (B2.1.20)	*N/A — AMP exclusively for PWRs*	*N/A — AMP not implemented at RNP*
XI.M16A	PWR Vessel Internals	Reactor Vessel Internals (B2.1.27)	*N/A — AMP exclusively for PWRs*	PWR Vessel Internals (B4.3)
XI.M17	Flow-Accelerated Corrosion	Flow-Accelerated Corrosion (B2.1.15)	Flow-Accelerated Corrosion Program (B2.1.9)	Flow-Accelerated Corrosion (B3.3)
XI.M18	Bolting Integrity	Bolting Integrity (B2.1.5)	Bolting Integrity Program (B2.1.36)	Bolting Integrity (B3.4)
XI.M19	Steam Generators	Steam Generator Tube Integrity (B2.1.31)	*N/A — AMP exclusively for PWRs*	Steam Generator Tube Integrity (B2.4)
XI.M20	Open Cycle Cooling Water System	Open-Cycle Cooling (Service) Water (B2.1.22)	Open Cycle Cooling Water System Program. (B2.1.10)	Open-Cycle Cooling Water System (B3.5)
XI.M21A	Closed Treated Water System	Closed-Cycle (Component) Cooling Water System (B2.1.9)	Closed-Cycle Cooling Water System Program (B2.1.11)	Closed-Cycle (Component) Cooling Water System (B2.5)
XI.M22	Boraflex Monitoring	*N/A — see AMP XI.M40*	Boraflex Monitoring Program (B2.1.12)	*N/A — AMP not implemented at RNP*
XI.M23	Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems	Heavy & Light Load (Related to Refueling) Handling Syst (B2.1.18)	Inspection of Overhead Heavy Load and Light Load Handling Systems Program (B2.1.13)	Inspection of Heavy & Light Load (Related to Refueling) Handling Systems (B3.6)
XI.M24	Compressed Air Monitoring	Compressed Air Monitoring (B2.1.10) (also see AMP B2.1.33)	Compressed Air Monitoring Program (B2.1.14)	*N/A — AMP not implemented at RNP*

Table 3.1 Relationship between GALL AMPs and those Implemented at the Audited Plants

GALL AMP ID	GALL AMP	Ginna (WEST 2LP PWR) NUREG-1786 AMP Reviewed	NMP-1 (Mark-I BWR) NUREG-1900 AMP Reviewed	RNP (PWR) NUREG-1785 AMP Reviewed
XI.M25	BWR Reactor Water Cleanup System	*N/A — AMP exclusively for BWRs*	BWR Reactor Water Cleanup (RWCU) System Program (B2.1.15)	*N/A — AMP exclusively for BWRs*
XI.M26	Fire Protection	Fire Protection (B2.1.13)	Fire Protection Program (B2.1.16)	Fire Protection (B3.1)
XI.M27	Fire Water System	Fire Water System (B2.1.14)	Fire Water System Program (B2.1.17)	Fire Water System (B3.7)
XI.M28	Buried Piping and Tanks Surveillance – *retired after GALL Rev. 1.*	*N/A — see AMP XI.M41*	*N/A — see AMP XI.M41*	Buried Piping and Tanks Inspection (Surveillance (B3.8)
XI.M29	Above Ground Metallic Tanks	Aboveground Carbon Steel Tanks (B2.1.1)	*N/A — AMP not implemented at NMP-1 which credits plant-specific Preventive Maintenance Program (B2.1.32) and Systems Walkdown Program (B2.1.33)*	Aboveground Carbon Steel Tanks (B3.9)
XI.M30	Fuel Oil Chemistry	Fuel Oil Chemistry (B2.1.16)	Fuel Oil Chemistry Program (B2.1.18)	Fuel Oil Chemistry (B3.10)
XI.M31	Reactor Vessel Surveillance	Reactor Vessel Surveillance (B2.1.28)	Reactor Vessel Surveillance Program (B1.1.19)	Reactor Vessel Surveillance (B3.11)
XI.M32	One-Time Inspection	One-Time Inspection (B2.1.21)	One-Time Inspection Program (B2.1.20)	One-Time Inspection (B4.4)
XI.M33	Selective Leaching	Selective Leaching of Materials (B2.1.29)	Selective Leaching Program (B2.1.21)	Selective Leaching of Materials (B4.5)
XI.M34	Buried Piping and Tanks Inspection – *retired after GALL Rev. 1.*	*N/A — see AMP XI.M41*	*N/A — see AMP XI.M41*	Buried Piping and Tanks Inspection (B3.12)
XI.M35	One-time Inspection of ASME Code Class 1 Small Bore-Piping – *first introduced in GALL Rev. 1.*	*N/A — No audit — LRA prepared under GALL Rev. 0*	*N/A — No audit — LRA prepared under GALL Rev. 0*	*N/A — AMP not implemented at RNP*
XI.M36	External Surfaces Monitoring of Mechanical Components – *first introduced in GALL Rev. 1.*	*N/A — LRA prepared under GALL Rev. 0 & credits plant-specific System Monitoring program (B2.1.33)*	*N/A — LRA prepared under GALL Rev. 0 & credits plant-specific Systems Walkdown Program (B2.1.33)*	*N/A — LRA prepared under GALL Rev. 0 & credits* Systems Monitoring (B3.17)
XI.M37	Flux Thimble Tube Inspection – *first introduced in GALL Rev. 1.*	*N/A — LRA prepared under GALL Rev. 0 & credits plant-specific Thimble Tube Inspection Program (B2.1.36)*	*N/A — AMP exclusively for PWRs*	Flux Thimble Eddy Current Inspection (B2.8)

Table 3.1 Relationship between GALL AMPs and those Implemented at the Audited Plants

GALL AMP ID	GALL AMP	Ginna (WEST 2LP PWR) NUREG-1786 AMP Reviewed	NMP-1 (Mark-I BWR) NUREG-1900 AMP Reviewed	RNP (PWR) NUREG-1785 AMP Reviewed
XI.M38	Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components – *first introduced in GALL Rev. 1.*	*N/A — LRA prepared under GALL Rev. 0 & credits plant-specific Periodic Surveillance and Preventive Maintenance program (B2.1.23)*	*N/A — LRA prepared under GALL Rev. 0 & credits plant-specific Preventive Maintenance Program (B2.1.32)*	*N/A — LRA prepared under GALL Rev. 0 & credits plant-specific Preventive Maintenance Program (B3.18)*
XI.M39	Lubricating Oil Analysis – *first introduced in GALL Rev. 1.*	*N/A — No audit — LRA prepared under GALL Rev. 0 & credits plant-specific Periodic Surveillance and Preventive Maintenance program (B2.1.23)*	*N/A — No audit*	*N/A — AMP not implemented at RNP*
XI.M40	Monitoring of Neutron Absorbing Materials Other than Boraflex – *first introduced in GALL Rev. 2.*	Spent Fuel Pool Neutron Absorber Monitoring (B2.1.30)	N/A — *see AMP XI.M22*	*N/A — AMP not implemented at RNP*
XI.M41	Buried and Underground Piping and Tanks – *first introduced in GALL Rev. 2.*	Buried Piping and Tanks Inspection (B2.1.7) Buried Piping and Tanks Surveillance (B2.1.8)	Buried Piping and Tanks Surveillance (B2.1.28)	Buried Piping and Tanks Inspection (B3.12) & Surveillance (B3.8) – audited together
---	*No GALL counterpart to plant-specific program*	*N/A — plant-specific AMP not discussed at Ginna*	*N/A — plant-specific AMP not discussed at NMP-1*	Plant-specific Systems Monitoring (B3.17)
AMPS for Structural Systems				
X.S1 (TLAA)	Concrete Containment Tendon Prestress	Concrete Containment Tendon Prestress (B3.3)	N/A — *NMP-1 has steel containment*	N/A
XI.S1	ASME Section XI, Subsection IWE	ASME Section XI, Subsections IWE and IWL Inservice Inspection (B2.1.3) *(combining XI.S1, XI.S2, and XI.S4)*	ASME Section XI Inservice Inspection (Subsection IWE) Program (B2.1.23)	ASME Sect XI, Subsections IWE Inservice Inspection (B3.13)
XI.S2	ASME Section XI, Subsection IWL	ASME Section XI, Subsections IWE and IWL Inservice Inspection (B2.1.3) *(combining XI.S1, XI.S2, and XI.S4)*	*N/A — AMP not implemented at NMP-1, only at NMP-2*	ASME Sect XI, Subsections IWL Inservice Inspection (B3.14)
XI.S3	ASME Section XI, Subsection IWF	ASME Section XI, Subsections IWF Inservice Inspection (B2.1.4)	ASME Section XI Inservice Inspection (Subsection IWF) Program (B2.1.25)	ASME Section XI, Subsection IWF, Inservice Inspection (B2.6)

Table 3.1 Relationship between GALL AMPs and those Implemented at the Audited Plants

GALL AMP ID	GALL AMP	Ginna (WEST 2LP PWR) NUREG-1786 AMP Reviewed	NMP-1 (Mark-I BWR) NUREG-1900 AMP Reviewed	RNP (PWR) NUREG-1785 AMP Reviewed
XI.S4	10 CFR 50, Appendix J	ASME Section XI, Subsections IWE and IWL Inservice Inspection (B2.1.3) *(combining XI.S1, XI.S2, and XI.S4)*	10 CFR 50 Appendix J Program (B2.1.26)	10 CFR Part 50, Appendix J (B2.7) (containment leak rate tests)
XI.S5	Masonry Walls	Structures Monitoring (B2.1.32) *(combining XI.S5, XI.S6, and XI.S7)*	Masonry Wall Program (B2.1.27)	Structures Monitoring (B3.15) *(combining XI.S5 and XI.S6)*
XI.S6	Structures Monitoring	Structures Monitoring (B2.1.32) *(combining XI.S5, XI.S6, and XI.S7)*	Structures Monitoring Program (B2.1.28)	Structures Monitoring (B3.15) *(combining XI.S5 and XI.S6)*
XI.S7	RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants	Structures Monitoring (B2.1.32) *(combining XI.S5, XI.S6, and XI.S7)*	N/A — *auditor reviewed NMP-1 plant-specific Periodic Surveillance and Preventive Maintenance Program*	Implemented through plant-specific Dam Inspection (B3.16)
XI.S8	Protective Coating Monitoring and Maintenance Program	Protective Coatings Monitoring and Maintenance Program (B2.1.24)	Protective Coating Monitoring and Maintenance Program (B2.1.38)	"Primary Containment Coatings Condition Assessment" which replaced a site procedure
---	*No GALL counterpart to plant-specific program (related AMR line-item II.B1.2.CP-63 credits XI.S1 and XI.S4 and possible additional plant-specific activities)*	*N/A — plant-specific AMP not discussed at Ginna*	Drywell Supplemental Inspection *(specific to NMP-1)*	*N/A — plant-specific AMP not discussed at RNP*
---	*No GALL counterpart to plant-specific program (related AMR line-item II.B1.1.CP-48 credits XI.S1 and XI.S4 and possible additional plant-specific activities)*	*N/A — plant-specific AMP not discussed at Ginna*	Torus Corrosion Monitoring *(specific to NMP-1)*	*N/A — plant-specific AMP not discussed at RNP*
---	*No GALL counterpart to plant-specific program*	*N/A — plant-specific AMP not discussed at Ginna*	*N/A — plant-specific AMP not discussed at NMP-1*	Dam Inspection (B3.16)
AMPS for Electrical Systems				
X.E1 (TLAA)	Environmental Qualification of Electrical Equipment	Environmental Qualification (B3.1)	Environmental Qualification	*N/A — AMP not implemented at RNP*

Table 3.1 Relationship between GALL AMPs and those Implemented at the Audited Plants

GALL AMP ID	GALL AMP	Ginna (WEST 2LP PWR) NUREG-1786 AMP Reviewed	NMP-1 (Mark-I BWR) NUREG-1900 AMP Reviewed	RNP (PWR) NUREG-1785 AMP Reviewed
XI.E1	Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements	Electrical Cables and Connections Not Subject to EQ (B2.1.11)	Non-EQ Electrical Cables and Connections	Non-EQ Insulated Cables and Connections (B4.6)
XI.E2	Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits	Electric Cables Not Subject to EQ Used in Instrumentation Circuits (B2.1.12)	Non-EQ Electrical Cables and Connections used in Instrumentation Circuits (B2.1.30)	Non-EQ Electrical Cables used in Instrumentation Circuits
XI.E3	Inaccessible Power Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements	Inaccessible Medium-Voltage Cables Not Subject to EQ (B2.1.17)	*N/A — AMP not implemented at NMP-1, only at NMP-2*	Inaccessible Power Cables Not Subject to 10 CFR 50.49 EQ Requirements (B33)
XI.E4	Metal-Enclosed Bus – *first introduced in GALL Rev. 1*	*N/A — LRA prepared under GALL Rev. 0 & credits site-specific Periodic Surveillance and Preventive Maintenance program (B2.1.23)*	Non-Segregated Bus Inspection *(B2.1.34 site-specific)*	Bus Ducts
XI.E5	Fuse Holders – *first introduced in GALL Rev. 1.*	*N/A — LRA prepared under GALL Rev. 0 , no counterpart site-specific AMP*	Non-EQ Electrical Cable Metallic Connections/ fuse holder inspection program *(B2.1.35 site-specific)*	Fuse Holders
XI.E6	Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements – *first introduced in GALL Rev. 1.*	Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (B2.1.11)	Non-EQ Electrical Cable Metallic Connections/ fuse holder inspection program *(B2.1.39 site-specific)*	*N/A — No audit — LRA prepared under GALL Rev. 0*
---	*No GALL counterpart to plant-specific program*	*N/A — plant-specific AMP not discussed at Ginna*	*N/A — plant-specific AMP not discussed at Ginna*	Neutron Flux Instrumentation Circuits

SECTION 4
Evaluation of AMP Effectiveness at Ginna and NMP-1

4.1 Overview

In this Section, we provide detailed information on the various AMP effectiveness audit (AEA) technical areas and evaluation of the effectiveness as observed. The overview Subsection provides a summary of the audits from both Ginna and NMP-1 and results from these audits.

4.1.1. Summary of the AMP Effectiveness Audit at the Ginna NPS

During the week of August 30 -September 1, 2011, the U.S. Nuclear Regulatory Commission (NRC) staff performed an audit of aging management programs (AMPs) at the Constellation Energy, LLC's R.E. Ginna Nuclear Power Plant (Ginna). Prior to the audit, Constellation Energy set up a portal on the Internet and provided the NRC staff web access to the portal. The staff examined the license renewal application (LRA) for Ginna, staff's Safety Evaluation Report (SER), Program Basis Document (PBD) for each AMP, Condition Reports (CRs), Corrective Action Plans (CAPs) and Trending Reports which were available on the portal. During the audit, the staff further examined the implementing procedure documents which implemented the AMPs, the condition reports, and work orders related to each AMP. The staff interviewed AMP owners and staff responsible for the implementation of each of the AMPs.

Table 3.1 tabulates all the NUREG-1801 AMPs and their counterparts at the plants audited. In Sections 4.2.x.2, this TLR provides observations from Ginna or NMP-1 on each mechanical AMP audited; in sections 4.3.x.2, observations from Ginna or NMP-1 concerning structural AMPs are summarized, and in sections 4.4.x.2, observations from Ginna or NMP-1 concerning electrical AMPs are summarized. The information is more fully presented in the earlier NRC TLR, *Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna and Nine Mile Point Nuclear Station, Unit 1*, May 2013 (ML13122A009). Appendix A provides a full list of NRC participants and Ginna interviewees and documents reviewed before, during, and after the site visit.

The general observations of the NRC staff regarding the licensee's implementation of AMPs are:

- The AMPs at Ginna are implemented through various plant procedures with specific personnel assigned as AMP owners.
- AMP owners were generally knowledgeable about their specific programs and the documentations required for implementation of each program.
- Controls were in place to maintain documentation, such as procedures that are "hardened" so that those specifically associated with license renewal can't be changed without approval from the Program Owner or License Renewal Program Manager.
- In trying to gain an understanding of how AMPs have changed since implementation and any aging related issues that may have led to such changes, the staff was not able to easily trace the issues in Condition Reports or the licensee's Corrective Action Program, as aging degradation was not specifically singled out as a category.

The brief overview and summary of the audit and information gathered as mentioned above was transmitted to the licensee in February 2012 (NRC ADAMS Accession Number: ML 11293A039).

4.1.2 Summary of the AMP Effectiveness Audit at NMP-1 NPS

During the week of November 1 -3, 2011, the NRC staff performed an audit of AMPs at the Constellation Energy, LLC's, NMP-1. Prior to the audit, Constellation Energy set up a portal on the Internet and provided the NRC staff Web access to the portal. The staff examined the license renewal application for NMP-1, staff's Safety Evaluation Report, Program Basis Document for each AMP, and NMP-1's self-assessment of the AMPs which were available on the portal. During the audit, the staff further examined the implementing procedure documents which the AMPs put into practice, the condition reports, and work orders related to each AMP. The staff interviewed AMP owners and staff responsible for the implementation of each of the AMPs. Appendix A provides a full list of NRC participants and Ginna interviewees and documents reviewed before, during, and after the site visit.

The NRC staff also reviewed the changes that have been made to the commitments the licensee made during the license renewal review process. Changes to these commitments are allowed under Title 10 of the Code of Federal Regulation (CFR) 50.59 if such changes meet criteria as specified in 10 CFR 50.59(c)(2).

The staff interviewed AMP owners and staff responsible for the implementation of each of the AMPs. Table 3.1 tabulates all the NUREG-1801 AMPs and their counterparts at the plants audited. In Sections 4.2.x.2, this report provides observations from Ginna or NMP-1 on each mechanical AMP audited; in sections 4.3.x.2, observations from Ginna or NMP-1 concerning structural AMPs are summarized, and in sections 4.4.x.2, observations from Ginna or NMP-1 concerning electrical AMPs are summarized. The information is more fully presented in the 2013 NRC TLR, *Summary of Aging Management Program Effectiveness Audits to Inform Subsequent License Renewal: R.E. Ginna and Nine Mile Point Nuclear Station, Unit 1*, May 2013 (ML13122A009). Appendix A provides a full list of NRC participants and NMP-1 interviewees and documents reviewed before, during, and after the site visit.

Staff’s general observations regarding the licensee's implementation of AMPs are:

- The AMPs at NMP-1, as approved through the LRA review, have been updated at least once prior to beginning the period of extended operation, and have been translated into a large number of implementing procedures.
- AMP owners were generally knowledgeable about their specific programs and the documentation required for implementation of each program. However, some of the AMP owners were relatively new and managed multiple AMPs.
- Controls were in place to maintain documentation, such as procedures that are "hardened" so that those specifically associated with license renewal can't be changed without approval from the Program Owner or License Renewal Program Manager.
- NMP-1 had done its own self-assessment of the implementation of a sample of its license renewal AMPs.
- Plant personal were trained in identifying aging. Checklists were included with procedures to verify that aging was or was not occurring.

In trying to gain an understanding of how AMPs have changed since implementation because of aging related issues that may have led to such changes, the staff was not able to easily trace the issues in condition reports or the licensee's Corrective Action Program, as aging degradation was not specifically singled out as a category. In the future, the licensee should

work to maintain knowledge of the history and evolution of its AMPs to insure that a culture of actively seeking and managing aging will be maintained.

The brief overview and summary of the audit and information gathered as mentioned above was transmitted to the licensee in February 2012 (NRC ADAMS Accession Number: ML 12041A161).

4.2 AMPs for Mechanical Systems

4.2.1 ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD (XI.M1)

4.2.1.1 Objective and Scope of AMP XI.M1

The objective of this AMP is to meet the 10 CFR 50.55a inspection requirements, as part of the license renewal requirements under 10 CFR 54.35, which include the ASME Code Section XI, ISI (under its Subsections IWB, IWC, and IWD), and related limitations, modifications, or augmentations for license renewal period or actions. In addition, the requirements of 10 CFR 50.55a paragraph (b) "Standards approved for incorporation by reference" will be satisfied.

This AMP includes (a) all pressure retaining RCPB components, including pumps and valves, and their supports, which must meet the requirements for ASME Code Class 1 components; and (b) other safety-related pressure vessels, piping, pumps and valves, and their supports, which must meet the requirements for ASME Code Class 2 or Class 3 components. These requirements include various forms of visual, surface, and volumetric examinations, as well as the system leakage and pressure tests for leakage detection requirements [10CFR 50.55a(b)(2)];10 CFR 50.55a specifies frequency and acceptable methods of testing and examination. For these components (including their supports and integral attachments) the aging effects addressed by this AMP include cracking (due to SCC, IGSCC, PWSCC, and cyclic loads), loss of material (due to pitting, corrosion, and wear), and loss of fracture toughness (due to thermal aging). This ASME Section XI ISI AMP has been credited by several other AMPs and is used to supplement many AMPs, with very broad scope and implications.

To ensure that potential degradation due to the aging effects of cracking, loss of material, and loss of fracture toughness would be adequately managed such that the intended functions of RCPB and other safety-related systems and their supports are maintained during the PEO, the AMP relies primarily on three aging management activities (AMAs):

(a) The existing (plant-specific) ASME Section XI ISI program structure (methods, tools, and techniques) and results of its periodic examinations and tests for the ASME Code Class 1, 2, and 3 components. ASME Section XI ISI activities are used to support the implementation of 10 CFR 50.55a inspection requirements.

(b) The required repair and replacement actions, if any, as per ASME Section XI, Subsection IWA.

(c) The plant-specific ISI program activities that may include other considerations such as risk-informed ISIs, relief requests, and in the case of BWRs, some BWRVIP requirements, as approved by the Staff.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Code Section XI, Subsections IWB, IWC, and IWD;
(ii) ASME Code Section XI, Subsection IWA; and
(iii) Parts of 10 CFR 50.55a, including limitations, modifications, or augmentations (of the Code activity), specifically related to the license renewal period or actions.

4.2.1.2 Observations from the AMP Effectiveness Audits at Gina and NMP-1

Ginna implements this program through its AMP B2.1.2, “ASME Section XI, Subsections IWB, IWC, & IWD Inservice Inspection,” and NMP-1 through its AMP B2.1.1, “ASME Section XI Inservice Inspection (Subsections IWB, IWC, IWD) Program.” . See AEA TLR, ML13122A009, for further details.

It was noted during the audits that plant-specific considerations, such as any risk-informed ISI, relief requests, and in the case of BWRs, some BWRVIP requirements, are likely to impact the scope and requirements of ASME Section XI ISI implementation.

The staff noted that NMP-1’s request for permanent relief from examining reactor pressure vessel (RPV) circumferential welds and its proposal to perform only two to three percent of the circumferential welds that intersect longitudinal welds, for the extended period of operation, was approved by NRC on April 3, 2009. The staff determined that NRC approved, on March 15, 2010, NMP-1’s relief request to implement the risk-informed/safety-based ISI program for the Code Class 1 and 2 piping system.

The staff noted that in response to leakage through the lower head of the NMP-1 reactor vessel penetrations for the control rod drive (CRD) mechanisms, repairs have been made by roll expanding the CRD housing in order to stop or limit the reactor coolant leakage. The staff also noted that, during the LRA process, NMP-1 was mandated to commit to implement ASME Code Case N-730, and that an ultrasonic testing (UT) examination of the roll-expanded CRD housing shall be performed in accordance with the code case on at least 10 percent of previously rolled housing during each inspection interval.

The staff’s review of plant-specific operating experience of NMP-1 revealed deviation event reports ([DERs] which have since been re-termed Condition Reports [CRs]) documenting indications of flaws in recirculation components, piping, and various nozzle connection welds. The staff noted that deficiencies identified by the applicant’s ASME Section XI ISI program have been repaired, replaced, or evaluated in accordance with ASME Section XI and NMP-1 implementing procedures.

During the NMP-1 audit, the staff also noted that the current ISI program has been tracking eight previously identified flaw indications that were conditionally accepted by analytical evaluation and subsequently approved by the NRC, for which flaw re-examination will continue to be performed as required by ASME code.

4.2.1.3 Effectiveness of AMP XI.M1 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the “program description” and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, “AMP Worksheet ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD.” The significant results related to the adequacy of the program description and the effectiveness and

implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan for license renewal (SRP-LR), are listed in Subsection 4.2.1.4.

4.2.1.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description of GALL, Rev. 2, AMP XI.M1 does not state its objective, nor does it include the purpose of the AMP as to which aging effects caused by what aging degradation mechanism are being managed by the AMP.

(b) The plant-specific considerations – such as any risk-informed in-service inspection (ISI), relief requests, and in the case of BWRs, some BWRVIP requirements – are likely to impact the scope and requirements of ASME Section XI ISI implementation. The relationship and precedence of these considerations vis-à-vis the ASME Section XI ISI Program is not clear from the GALL AMP description.

(c) Likewise, the GALL AMP description does not address any of the differences between the inspection requirements in various editions of the ASME Code Section XI ISI (Subsection IWB, IWC, and IWD), and between these Code requirements and the industry guidelines, such as in BWRVIP documents, all of which may be active (or applicable) in a plant-specific setup.

(d) The GALL AMP does not require the applicant to state the actual Code Edition, any Code Cases, and/or industry guidance documents, or any augmentation used in the plant implementation.

(e) It is not clear from the program description, or other program elements, whether there is a requirement for updating the plant-based (implemented) AMP, with its review by the Staff, every 10 years.

4.2.1.3.2 Effectiveness and Implementation of AMP XI.M1

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3 of this report. The significant results of the evaluation are as follows:

(a) Due to the changes in Code requirements, related nondestructive examination (NDE) technology, and limitations of Code Cases applicability, the program update (by the licensee) and its review (by the NRC staff) are essential parts of the AMP to ensure its effectiveness in the period of extended operation (PEO) from 60-80 years. Perhaps the GALL AMP should provide specific guidance on this subject.

(b) Program Element 1, “Scope of Program,” does not include the system leakage and pressure tests for leakage detection requirements [10CFR 50.55a(b)(2)] and timely repair and replacement requirements (covered under Subsection IWA of ASME Section XI), both of which are integral to the effectiveness of the AMP.

(c) Program Element 2, “Preventive Actions,” lists this as a condition monitoring AMP, whereas its primary focus appears to be on predefined (or as-specified) inspections or needed subsequent inspections, with only marginal monitoring or condition-monitoring attributes.

(d) Program Element 3, “Parameters Monitored/Inspected,” notes the use of ASME Section XI IWB-2500 (2001 Edition in GALL, Rev. 1, and 2004 Edition in GALL, Rev. 2), which eliminated the requirement of volumetric examination for pump casing welds, whereas ASME Code Case N-481 has been in use to support alternative examination for these welds, which requires flaw tolerance evaluation on the basis of a volumetric examination. For similar welds on valve bodies (greater than 4-in. nominal pipe size [NPS]) the volumetric examination is required. These conflicting requirements need to be reconciled and the basis for these to be examined and/or documented.

(e) Program Element 6, “Acceptance Criteria,” does not cover or address all ISIs – e.g., those augmented by a risk-informed program that may be performance-based (in contrast to flaw evaluation based).

4.2.1.4 Recommendations for Subsequent License Renewal

4.2.1.4.1 Good Practices or Existing Strengths of AMP XI.M1

M1.S-1: *Recommendation*: Licensee’s confirmatory action of performing review of OpE and program health reports for periodic assessment and improvement of AMP effectiveness is considered a good practice or strength. For maintaining the AMP effectiveness, especially during the PEO, it is recommended that a program self-assessment be documented subsequent to each scheduled outage, based on the findings of the outage, with expectations for the next outage summarized for reference and baseline.
***Technical Basis*:** Based on the review of operating experience (OpE), licensees generate and review program health reports for the ASME Section XI ISI Program. The purpose of these reports is periodic assessment to confirm the AMP expectations and to identify any changes to program activities for improving the AMP effectiveness.

4.2.1.4.2 Areas of AMP XI.M1 for Further Consideration/Enhancements

<u>Program Description</u>:

M1.0-1: *Recommendation*: The plant-specific ISI program is likely to include other considerations such as risk-informed ISI, relief requests, and in the case of BWRs, some BWRVIP requirements. Basic guidance for incorporating these considerations in relation to the ASME Section XI requirements and the license renewal objectives for the AMP should be provided or specified in the GALL AMP description.
***Technical Basis*:** The ASME Section XI ISI program has been credited by several other AMP/AMRs and is used to supplement many AMPs, with very broad scope and implications, with no clear nexus to aspects, such as risk-informed ISI, relief requests, and in the case of BWRs, some BWRVIP requirements, as noted above. Clarity and specific guidance on any allowed or approved deviations would improve both the implementation and the effectiveness of this and other related AMPs.

M1.0-2: *Recommendation*: The objective of this AMP and the aging effects it addresses need to be clearly stated and the AMP title should be reviewed to reflect its scope and intent. Consideration of the requirements of repair/replacement and system leakage and pressure tests

for leakage detection requirements [10CFR 50.55a(b)(2)] activities related to meet the program objectives should be included in the program description.
***Technical Basis*:** The ASME Section XI ISI program for periodic examinations and tests existed prior to and independent of the license renewal that is designed to address management of aging effects over the PEO. The license renewal related inspection basis is covered by 10 CFR 50.55a, which forms the primary focus of this GALL AMP, which utilizes the structure and consensus requirements of the ASME Section XI ISI.

M1.0-3: *Recommendation*: The AMP description should note (or clarify), as stated under 10 CFR 50.55a, the requirement for updating the program, with its review by the NRC staff (at least once) every 10 years. In addition, the requirement for updating programs, with review and approval by the NRC, with modifications to the ASME XI ISI, such as risk-informed inspections, should be noted in the GALL AMP.
***Technical Basis*:** Due to the changes in Code requirements, related NDE technology, and limitations of Code Cases applicability, the program update and its review are essential parts of the AMP that ensure its effectiveness in the PEO. In addition, the use of various (approved) ASME Code Cases, including those for relief requests such as the risk-informed process, and related updating of requirements with review, while possibly generally covered under 10 CFR 50.55a, are significant in scope. Noting the update and review process in the GALL AMP will make LRAs explicit and make apparent the evaluation of basis and adequacy of plant implementation of the AMP with such add-ons or deviations.

1. <u>Scope of Program</u>:

M1.1-1: *Recommendation*: The scope should include other major activities required in implementing the program: the repair and replacement requirements, as per ASME Section XI, Subsection IWA; and the performance of system leakage and pressure tests for leakage detection .requirements
***Technical Basis*:** The ASME Section XI ISI program includes system leakage and pressure tests of certain components for leakage detection, and Subsection IWA is invoked if acceptance criteria are not met. Both the AMP title and most program elements have emphasized the IWB, IWC, and IWD subsections, and inspection activity; however, the AMP effectiveness also relies and effective use of system leakage and pressure tests for leakage detection [10CFR 50.55a(b)(2)]requirements and timely repair replacement activities.

2. <u>Preventive Action</u>:

M1.2-1: *Recommendation*: This program has no preventive action associated with it, since it is primarily a program for periodic and selective inspections. It is prudent to assess the information from such inspections to determine the need for managing any observed changes in order to either prevent recurrence or disposition the changes to assure that expected or required performance would not be impacted. It may include some monitoring aspect and/or performance evaluation on the basis of results of the periodic inspections.
***Technical Basis*:** The focus of this AMP is on predefined (or as-specified) inspections or needed subsequent inspections, following the primary guidance of ASME Section XI ISI as modified for license renewal under 10 CFR 10.55a, with only marginal monitoring or condition monitoring attributes.

3. <u>Parameters Monitored/Inspected</u>:

M1.3-1: *Recommendation*: Reconcile the differences in requirements concerning the volumetric examination of pump casing welds and valve body welds, providing the technical basis and guidance on the use of IWB-2500 vis-à-vis Code Case N-481 relating to these volumetric examinations.
***Technical Basis*:** There are two conflicting or confounding aspects to using the IWB-2500 requirements of the latest ASME Code Section XI: (1) volumetric examination for pump casing welds is dropped, but the Code Case N-481 often used for alternative examination for these welds requires flaw tolerance evaluation; and (2) volumetric examination is required for similar welds on valve bodies (greater than 4-in. NPS). In addition, there is no referenced document providing a technical basis for the elimination of volumetric examination of these welds.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M1.6-1: *Recommendation*: Provide (or include) a set of acceptance criteria (or basis), which may be performance based, for those inspections that deviate from the Section XI ISI (e.g., augmented by risk-informed program).
***Technical Basis*:** The acceptance standards of ASME Sec XI IWB-3400 and IWB-3500, or IWC-3400 and IWC-3500, respectively, for Class 1 or Class 2 and 3 components are generally condition based (i.e., address dispositioning of as-found flaws). The risk-informed ISI and other augmentations of the ASME Section XI basis ISI are likely at least partly performance-based, requiring a different set of acceptance criteria.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

No further review item identified.

4.2.2 Water Chemistry (XI.M2)

4.2.2.1 Objective and Scope of AMP XI.M2

The objective of this AMP is to mitigate loss of material due to corrosion, cracking due to SCC and related degradation mechanisms, and reduction of heat transfer due to fouling in components exposed to a treated water environment. The program includes periodic monitoring of the treated water in order to minimize loss of material or cracking.

The water chemistry program for BWRs relies on monitoring and control of reactor water chemistry based on the most recent NRC-approved industry guidelines. Currently, these guidelines for BWRs are contained in BWRVIP-190 (EPRI1016579). BWRVIP-190 has three sets of guidelines: one for reactor water, one for condensate and feedwater, and one for CRD mechanism cooling water. The water chemistry program for PWRs relies on monitoring and control of reactor water chemistry based on industry guidelines contained in EPRI 1014986 (PWR Primary Water Chemistry Guidelines – Revision 6) and EPRI 1016555 (PWR Secondary Water Chemistry Guidelines – Revision 7).

The water chemistry programs are generally effective in removing impurities from intermediate- and high-flow areas. The GALL Report identifies those circumstances in which the water chemistry program is to be augmented to manage the effects of aging for license renewal. For example, the water chemistry program may not be effective in low-flow or stagnant-flow areas. Accordingly, in certain cases as identified in the GALL Report, verification of the effectiveness of the chemistry control program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the PEO. For these specific cases, a one-time inspection of selected components at susceptible locations in the system is an acceptable verification program.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines-2008 Revision*;
(ii) EPRI 1014986, *PWR Primary Water Chemistry Guidelines, Revision 6*, Volumes 1 and 2, 2009; and
(iii) EPRI 1016555, *PWR Secondary Water Chemistry Guidelines, Revision 7*, 2009.

4.2.2.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.37, "Water Chemistry Control," and NMP-1 through its AMP B2.1.2, "Water Chemistry Control Program." The Ginna LRA cites EPRI Topical Report (TR) TR-105714, Rev. 4, for primary systems chemistry and EPRI TR-102134, Rev. 5, for secondary systems chemistry. Further details are included in the AEA TLR, ML13122A009.

Monthly self-assessments provide a basis for the continued improvement of program performance. Ginna implemented a 17 percent power uprate at the beginning of Cycle 33 (fall of 2006). During the subsequent Cycle 34 (beginning in the spring of 2008), iron transport was a little higher as indicated by a review of primary and secondary chemistry. During Cycle 34, approximately 89 lb. of iron oxides were transported by the feedwater (FW) to the steam generators. At the time of the AMP audit, only limited OpE (a few operating cycles) was available with respect to the possible effects of power uprate on water chemistry control.

NMP-1 likewise took an exception to the GALL Report in that, when the EPRI or BWRVIP water chemistry guidance document cited in the GALL Report is updated, it uses the updated document. The amended LRA cites EPRI TR-103515, Rev. 1 and 2. In addition, the NMP-1 program takes an exception in that electrochemical potential (ECP) is monitored only under hydrogen water chemistry (HWC) operation, and it also takes exception to the GALL Report, Rev. 0, recommendation for monitoring of hydrogen peroxide. The licensee justifies the latter exception because accurate measurement of this chemical is extremely difficult due to its rapid decomposition in the sample lines. As an alternative, it monitors the molar ratio of hydrogen to oxygen, consistent with EPRI TR-103515, Rev. 2. As noted in NUREG-1950, Table IV-12, Element 3 of this AMP was changed in GALL Report, Rev. 2, to be consistent with the most recent EPRI BWR Water Chemistry Guidelines (BWRVIP-190, EPRI 1016579).

A review of water chemistry OpE at NMP-1 during the audit revealed problems in implementing HWC. The noble metal chemical application and zinc FW additions programs have been operating as expected. The licensee subsequently noted that the problems with the HWC had been primarily due to the hydrogen supply line. This issue has been resolved and the system now operates with approximately 98 percent availability, which meets the industry guidelines. Ginna also reported water chemistry control problems. The problems generally involved levels of specific impurities exceeding EPRI guidelines, particularly during startup and transient operating conditions, which are common responses of the plant, and are being addressed in the corrective action program.

4.2.2.3 Effectiveness of AMP XI.M2 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified as part of the program description and the ten program elements of the AMP. Selected highlights of information gathered from the plant visits and its assessment is included in Appendix Subsection A.2, “AMP Worksheet XI.M2 Water Chemistry.” The plant-specific information reviewed is listed under References in Appendix A. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or SRP-LR are listed in Subsection 4.2.2.4.

4.2.2.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description in GALL does not indicate that water chemistry industry guidelines cited therein are subject to periodic update, and it does not explicitly state that the applicant should update its water chemistry control practices with time to remain in conformance with the most recent NRC-approved guidance.

(b) The EPRI and BWRVIP guidelines cited by GALL continue to provide the best available guidance on water chemistry control, but no OpE is available to verify their continued effectiveness for operating periods beyond 60 years. Therefore, a one-time inspection program that samples the entire system should be considered prior to entering the PEO to verify the continued effectiveness of the GALL water chemistry guidance in controlling corrosion, SCC, and fouling before extending operating periods beyond 60 years. The scope and extent of this inspection program should be based in large part on the plant-specific OpE with respect to corrosion, SCC, and fouling in the systems and components managed by this AMP. Additional periodic inspections may also be required if problems related to water chemistry develop during the PEO. This is similar to the one-time inspection identified in the current program description for components in susceptible locations in the system.

(c) The program description fails to mention control of background radiation (primarily due to Co-60) as one of the objectives of the program.

The periodic updating of water chemistry guidance by NMP-1 and other plants to conform with the most recent NRC-approved industry standards, even though not explicitly recommended in GALL, is identified as a good practice. Information on the possible effects of power uprates on water chemistry control is given in Section 4.2.2.3, Item M2.10-2. The possible effects of other plant modifications on this AMP were not evaluated in the current study.

4.2.2.3.2 Effectiveness and Implementation of AMP XI.M2

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 2, “Preventive Actions,” mentions chemical additive programs such as HWC or noble metal chemical application as preventive water chemistry actions. However, it fails to mention the use of zinc additions for background radiation control.

(b) Program Element 4, “Detection of Aging Effects,” states that this is a mitigation program and does not provide for detection of any aging effects of concern for the components within its scope. However, the program description refers to the use of one-time inspections as an acceptable verification program for selected components at susceptible locations in the system.

4.2.2.4 Recommendations for Subsequent License Renewal

4.2.2.4.1 Good Practices or Strengths of AMP XI.M2

M2.S-1: *Recommendation*: At Ginna, monthly self-assessments are performed on both primary and secondary water chemistry as a part of the water chemistry program. With the information obtained, repetitive findings are identified and tracked. This activity is considered a good practice and should be included as a part of Program Element 5, “Monitoring and Trending.”
***Technical Basis*:** The results of such monthly self-assessments provide a basis for the continued improvement of program effectiveness.

4.2.2.4.2 Areas of AMP XI.M2 for Further Consideration/Enhancement

Program Description:

M2.0-1: *Recommendation*: Revise the AMP program description to state explicitly that the applicant should periodically update its water chemistry control practices to remain in conformance with the most recent NRC-approved guidance.
***Technical Basis*:** The GALL Report currently recommends BWR water chemistry guidelines contained in BWRVIP-190 (EPRI 1016579). The GALL-recommended water chemistry program for PWRs is contained in EPRI 1014986 (PWR Primary Water Chemistry Guidelines – Revision 6) and EPRI 1016555 (PWR Secondary Water Chemistry Guidelines – Revision 7). However, all of these documents are subject to periodic updates that reflect the most recent research results and OpE.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M2.4-1: *Recommendation*: A one-time inspection program that samples the entire system should be considered prior to entering the PEO to verify the continued effectiveness of the EPRI water chemistry guidance in controlling corrosion, SCC, and fouling before extending operating periods beyond 60 years. The scope and extent of this inspection program should be based in large part on the plant-specific OpE with respect to corrosion, SCC, and fouling in the systems and components managed by this AMP. Additional periodic inspections may also be required if problems related to water chemistry develop during the PEO.
***Technical Basis*:** The EPRI and BWRVIP guidelines cited by GALL continue to provide the best available guidance on water chemistry control, but no OpE is available to verify their continued effectiveness for operating periods out to and beyond 60 years.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M2.10-1: *Recommendation*: In addition to the one-time inspection prior to entering into the PEO, as recommended under item M2.4-1 above, the pre-SLR audit may need to verify that the applicant has achieved and is continuing to maintain a stable GALL-compliant water chemistry during the time period leading up to the audit.
***Technical Basis*:** A review of water chemistry OpE at NMP-1 during the recent audit revealed some technical challenges in implementing HWC.

M2.10-2: *Recommendation*: For any plants that have undergone a power uprate prior to LTO, the OpE subsequent to that uprate should be reviewed to verify stable GALL-compliant water chemistry prior to entering into LTO.
***Technical Basis*:** As noted in 4.2.1.2, Ginna uprated power by 17% at the beginning of Cycle 33, and, during the subsequent Cycle 34, iron transport was a little higher as indicated by a review of primary and secondary chemistry.

4.2.3 Reactor Head Closure Stud Bolting (XI.M3)

4.2.3.1 Objective and Scope of AMP XI.M3

This AMP manages the occurrence of cracking due to aging by mechanisms, such as stress corrosion cracking (SCC) or intergranular stress corrosion cracking (IGSCC) and loss of material due to wear or corrosion for reactor vessel closure stud bolting (studs, washers, bushings, nuts, and threads in flange) for both BWRs and PWRs.

To ensure that potential detrimental effects of cracking and loss of material would be adequately managed such that the intended function of the reactor closure head stud assemblies are maintained during the PEO, the AMP relies on two AMAs:

(1) Condition monitoring or ISI in accordance with the requirements of ASME Code, Section XI, Subsection IWB (2004 or later approved edition), Table IWB 2500-1, Examination Category B-G-1 to detect and size cracks and detect loss material, and Examination Category B-P to detect coolant leakage.

(2) Mitigation measures in accordance with the guidance delineated in NUREG-1339 and NRC Regulatory Guide (RG) 1.65. The following measures are recommended to either slow the effects of aging or decrease the chances of aging effects occurring:

   (a) Avoiding the use of metal-plated stud bolting to prevent degradation due to corrosion or hydrogen embrittlement;

   (b) Using manganese phosphate or other acceptable surface treatments;

   (c) Using stable lubricants. Of particular note, use of molybdenum disulfide (MoS_2) as a lubricant has been shown to be a potential contributor to SCC; it should not be used (RG 1.65);

   (d) Using bolting material for closure studs that has an actual measured yield strength less than 1,034 megapascals (MPa) (150 kilo-pounds per square inch) (NUREG-1339); and

   (e) During the venting and filling of the pressure vessel and while the head is removed, the studs and stud bolt holes in the vessel flange should be adequately protected from corrosion and contamination (RG 1.65).

Thus, the AMP relies on requirements or guidance from the following documents:

(i) ASME Section XI, Subsection IWB, Table IWB 2500-1, Examination Categories B-G-1 and B-P

(ii) RG 1.65, *Material and Inspection for Reactor Vessel Closure Studs*, Rev. 1, April 2010; and

(iii) NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, June 1990.

4.2.3.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.25, “Reactor Head Closure Studs.” The Ginna LRA states that the ISI portion of this program is included in its AMP B2.1.2, “ASME Section XI, Subsections IWB, IWC, & IWD Inservice Inspection.” As discussed in the SER for Ginna license renewal, the studs are fabricated with a specified minimum yield strength level of 105 ksi. Therefore, the actual yield strength levels of the closure studs may be greater than 150 ksi. Since stud materials with yield strength greater than or equal to 150 ksi are susceptible to stress corrosion cracking, cracking due to stress corrosion cracking is an applicable aging effect of the licensee’s reactor head closure studs to be managed.

In order to minimize the potential for stress corrosion cracking, the licensee’s Quality Assurance Program prohibits the use of lubricants containing molybdenum disulfide, which can promote stress corrosion cracking. In addition, the inservice inspection in accordance with ASME Code Section XI performs periodic volumetric examinations of the reactor head closure studs, which have been capable of detecting and managing cracks in the bolting components.

Based on its review of OpE, Ginna generates and reviews program health reports for the ASME Section XI ISI Program, which includes inspections of the reactor head closure studs. The purpose of these reports is periodic assessment and improvement of program performance. The licensee also indicated that these health reports have not identified a significant concern related to this program.

NMP-1 implements this program through its AMP B2.1.3, “Reactor Head Closure Studs Program,” which is consistent with the GALL program. The audit found that no aging-related degradation occurred in the NMP-1 closure stud assemblies.

4.2.3.3 Effectiveness of AMP XI.M3 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify the good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.3, “AMP Worksheet XI.M3 Reactor Head Closure Studs.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.3.4.

4.2.3.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description of GALL, Rev. 2, AMP XI.M3 does not describe which aging effects caused by what aging degradation mechanism are being managed by the AMP.

(b) The GALL AMP does not provide any guidance regarding the differences between the inspection requirements in different editions of the ASME Code Subsection IWB-2500, and for BWRs, between the ASME Code requirements and the guidelines in BWRVIP-74-A.

(c) Although the GALL Report describes the two AMAs of this AMP, namely condition monitoring and preventive actions, and refers to the two supporting documents, it does not provide any details regarding the specific guidance. Furthermore, it does not emphasize the importance or relevance of these actions in meeting the objectives of the AMP. For example, Ginna did not implement the preventive measures recommended in the AMP, and the inspection program was included in the GALL AMP XI.M1, ASME Section XI ISI, Subsections IWB, IWC, and IWD.

(d) For consistency and clarity, consideration may be given in revising the GALL AMP to provide clear guidance for the plants committed to following the program recommendations in GALL, Rev. 0, in its original LRA, regarding whether they should continue to follow the Rev. 0 guidance or switch to the recommendations of GALL, Rev. 2 or SLRGDs.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL AMP XI.M3. Therefore there have been no industry-proposed exceptions or enhancements to this AMP.

4.2.3.3.2 Effectiveness and Implementation of AMP XI.M3

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 2, “Preventive Actions,” does not provide any guidance for plants that have SCC susceptible materials (i.e., the material yield strength exceeds 1034 MPa or 150 ksi). Furthermore, this program element does not include the recommendation of RG 1.65 regarding protecting the studs and stud bolt holes in the vessel flange from corrosion and contamination during the venting and filling of the pressure vessel while the head is removed.

(b) Program Elements 3, “Parameters Monitored/Inspected,” and 4, “Detection of Aging Effects,” do not provide any guidance regarding the differences between the inspection requirements in different editions of the ASME Code Subsection IWB-2500, and for BWRs, between the ASME Code requirements and the BWRVIP-74-A guidelines.

(c) Since the major focus of this AMP is to manage the effects of SCC/IGSCC in leaking reactor coolant environment, to satisfy the recommendation in Applicant Action Item (AAI) #8 of the NRC SER for BWRVIP-74-A, the cumulative usage factor (CUF) analyses should also include the effect of leaking coolant environment.

4.2.3.4 Recommendations for Subsequent License Renewal

4.2.3.4.1 Good Practices or Existing Strengths of AMP XI.M3

M3.S-1: *Recommendation*: An activity performed under the licensee's confirmation actions, including review of OpE and program health reports for periodic assessment and improvement of program effectiveness, is considered a good practice or strength of the AMP.
***Technical Basis*:** Based on the review of OpE, licensees generate and review program health reports for the ASME Section XI ISI Program, which includes inspections of the reactor head closure studs. The purpose of these reports is periodic assessment and improvement of program effectiveness.

4.2.3.4.2 Areas of AMP XI.M3 for Further Consideration/Enhancements

Program Description:

M3.0-1: *Recommendation*: Revise the program description to include clear guidance for licensees who are currently following Section XI ISI, in accordance with the 1995 to 2000 editions of the ASME Code, but planning to follow 2001 or later editions for future inspections.
***Technical Basis*:** The GALL Report accepts or endorses ASME Section XI, Subsection IWB, for the 1995 to 2004 editions, as modified and limited in 10 CFR 50.55a, and more recent editions as evaluated in a Federal Register Notice (FRN) for 10 CFR 50.55a rulemaking. However, the inspection requirements for ASME, Section XI, Table IWB-2500-1, Examination Category B-G-1, for pressure retaining bolting greater than 2 inches in diameter, have changed significantly between the 1995 to 2000 editions and the 2001 and later editions of the Code. The former editions require a more stringent inspection and included Item B6.20, which specified volumetric examination of studs in place under tension, and Item B6.30, which specified surface and volumetric examination of studs when removed. The 2001 and later editions include only Item B6.30, and require volumetric examination of the studs in place under tension, when the connection is disassembled, or when removed.

M3.0-2: *Recommendation*: Revise the program description to include specific guidance for BWR licensees. In addition, the NRC SER for BWRVIP-74-A should be included as a supporting document for this AMP.
***Technical Basis*:** An inconsistency in the GALL AMP XI.M3 for closure studs is that the inspection program recommended in 2001 and later editions of the ASME Code is inconsistent with what is recommended in the BWRVIP-74-A document approved by the NRC in 2003. The BWRVIP-74-A program is consistent with the program recommended in 1995 to 2000 edition of the Code. After 2003, all BWR licensees are committed to follow the BWRVIP-74-A guidance, and are required to perform both surface and volumetric examination when the studs are removed, unless they have received NRC approval for deviation from BWRVIP-74-A guidance.

M3.0-3: *Recommendation*: Revise the program description to clearly identify the AMAs included in this AMP that are based on the guidance delineated in the supporting documents, and revise preventive actions program elements to include item 2(e) in Section 4.2.3.1.
***Technical Basis*:** Although the program description of the GALL AMP refers to the guidance of RG 1.65 and NUREG-1339, it does not provide any details about which particular guidance is being recommended in the AMP. It would be unambiguous and consistent in program implementation if the specific guidance in these documents were clearly identified. In addition, the preventive actions program element should include item 2(e) in Section 4.2.3.1 above regarding protecting the studs and stud bolt holes in the vessel flange from corrosion and

contamination during the venting and filling of the pressure vessel while the vessel head is removed.

M3.0-4: *Recommendation*: Revise the program description to clearly specify that this AMP consists of two AMAs and that both ISI and preventive actions are important components of the AMP.
***Technical Basis*:** As noted above in 4.2.3.2, there is potential SCC concern. NUREG-1786 states that since the reactor head closure studs program relies on ASME Section XI, Subsection IWB, to monitor for SCC, this aging effect will be managed by this program. However, for SLR, additional guidance should be included for plants with closure studs that may be susceptible to SCC.

M3.0-5: *Recommendation*: The program description should clarify that XI.M3 is a separate AMP and should not be included in another AMP such as XI.M1 ASME Section XI, ISI Subsections IWB, IWC, and IWD Program, and that the facility final safety analysis report (FSAR) supplement should include a summary description of this AMP.
***Technical Basis*:** The Ginna LRA Appendix Section A, "UFSAR Supplement," (Updated Final Safety Analysis Report Supplement) does not include a summary of this program; it does not refer to the guidance of NUREG-1339 and NRC RG 1.65 related to preventive measures to manage SCC of reactor head closure studs. The licensee indicated that the program basis document for the ASME ISI, Subsections IWB, IWC and IWD, Program includes the Reactor Head Closure Studs Program; therefore, no separate program basis document for the Reactor Head Closure Studs Program was prepared. Furthermore, AAI #2 associated with the NRC SER for BWRVIP-74-A also states that 10 CFR 54.21(d) requires that an FSAR supplement for the facility contain a summary description of the programs and activities for managing the effects of aging and the evaluation of time-limited aging analyses (TLAA) for the PEO.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

M3.2-1: *Recommendation*: Revise the Preventive Actions program element to include clear guidance for plants that have SCC susceptible materials (i.e., yield strength exceeds 1,034 MPa or 150 ksi).
***Technical Basis*:** To mitigate SCC, the GALL, Rev. 1, AMP XI.M3 recommends that the maximum tensile strength of the studs/nuts be limited to 1,172 MPa (170 ksi) (RG 1.65), whereas the GALL, Rev. 2, AMP provides a more conservative guidance and recommends using bolting material for closure studs that has an actual measured yield strength less than 1,034 MPa (150 ksi). Some heats or product lots of the closure studs bolting material are likely to exceed the yield strength limit, although they may or may not meet the maximum tensile strength limit of 170 ksi and, therefore, would be considered susceptible to SCC. For such situations, it may be recommended that a leakage event that may promote SSC of the reactor head closure bolting should be identified as an "operating experience precursor" that addresses a need for further AMA to ensure that the current conditions of the environment and components are acceptable with no significant adverse effect on the aging degradation of the reactor head bolting components. The following two AMP activities may be emphasized: (i) perform a flaw tolerance evaluation using fatigue crack growth (or both fatigue and SCC crack growth) to demonstrate the adequacy of ASME Code Section XI 10-yr inspection interval, and (ii) provide a safety assessment that evaluates the consequences of aging degradation.

3. <u>Parameters Monitored/Inspected</u>:

M3.3-1: *Recommendation*: Revise the parameters monitored/inspected program element to include clear guidance for BWR licensees who may have proposed ISI in accordance with different editions of ASME Section XI, Table IWB 2500-1, and also have committed to meet the requirements of the BWRVIP-74-A requirements for reactor head closure stud assemblies.
***Technical Basis*:** ISI in accordance with 2001 or later editions of ASME Section XI Table IWB-2500-1, Examination Category B-G-1, pressure retaining bolting >2 in. in diameter consists of: VT-1 of reactor vessel closure nuts; volumetric examination of closure head studs in place under tension, or when the connection is disassembled, or when the bolting is removed; volumetric exam of threads in the base material of the reactor flange; VT-1 of the closure head washers and bushings; volumetric exam of the flange ligaments; and VT-2 exam in conjunction with system leakage test. This requirement is significantly different than that in 1995 to 2000 editions of the Code or the requirements in BWRVIP-74-A.

4. <u>Detection of Aging Effects</u>:

M3.4-1: *Recommendation*: Revise the detection of aging effects program element to include clear guidance for BWR licensees who may have proposed ISI in accordance with different editions of ASME Section XI, Table IWB 2500-1, and also have committed to meet the requirements of the BWRVIP-74-A requirements for reactor head closure stud assemblies.
***Technical Basis*:** It is likely that several BWRs have proposed two different inspection programs for the PEO. In the LRA they may have proposed ISI in accordance with 2001 or later editions of ASME Section XI, Subsection IWB, while they are committed to follow the guidance of BWRVIP-74-A.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M3.10-1: *Recommendation*: The licensee performs self-assessment, which is considered a good practice for implementation of this AMP. Staff may consider revising either the "Confirmation Process" or "Monitoring and Trending" program element to recommend self-assessment to improve the program effectiveness.
***Technical Basis*:** As stated above in 4.2.3.2, Ginna generates and reviews program health reports for the ASME Section XI ISI Program, which includes inspections of the reactor head closure studs.

4.2.4 BWR Vessel ID Attachment Welds (XI.M4)

4.2.4.1 Objective and Scope of AMP XI.M4

The objective of this AMP is focused on managing the effects of cracking due to SCC or IGSCC on the long-term integrity and safe operation of BWR vessel inside diameter (ID) attachment welds (i.e., internal integral attachments). The program applies to the attachment welds between the reactor pressure vessel wall and the brackets that attach safety-related components to the vessel.

Examples of the attachment welds include jet pump riser brace attachments, core spray piping bracket attachments, and other bracket attachments for steam dryer support and hold-down, feedwater sparger, guide rod, and surveillance sample holder. In some cases, the attachment is a simple weld while in others; it includes a weld build-up pad on the vessel. The weld material is typically Alloy 182, and in some cases SS weld metal (E308/309) is used. The susceptibility of these materials to SCC depends on post-weld heat treatment, but is generally recognized to be greater for the Ni-alloy weld (Alloy 182).

To ensure potential detrimental effects of cracking would be adequately managed such that the intended functions of the internal integral attachments are maintained during the PEO, the AMP relies on two AMAs:

(1) Inspection and flaw evaluation in accordance with the guidelines of a Staff-approved BWRVIP-48-A, which includes information on the geometry of the vessel ID attachments; evaluation of susceptible locations and safety consequence of failure; and recommendations regarding the method, extent, and frequency of inspection; and discusses acceptable methods for evaluating the structural integrity significance of flaws detected during these examinations.

(2) Mitigation measures to reduce the corrosion potential or susceptibility for SCC or IGSCC by monitoring and control of reactor water chemistry based on the most recent NRC-approved industry guidelines. Currently, these guidelines for BWRs are contained in BWRVIP-190 (EPRI 1016579). However, reducing the corrosion potential by using HWC may not be effective in decreasing the SCC susceptibility of Ni-alloy welds.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) BWRVIP-48-A (EPRI 1009948), *BWR Vessel and Internals Project, Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines*
(ii) BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines-2008 Revision*; and
(iii) ASME Section XI, Subsections: IWA-3000 for flaw evaluation and IWA-4000 for repair/replacement activities; and the guidance of BWRVIP-14-A, BWRVIP-59-A, BWRVIP 60-A, BWRVIP-61, and BWRVIP-62 reports.;

4.2.4.2 Observations from NMP-1

This AMP is not applicable to Ginna, since it is a PWR. NMP-1 implements this program through its AMP B2.1.4, “BWR Vessel ID Attachment Welds Program.” The NMP-1 LRA states that this program is consistent with AMP XI.M4 of the GALL Report, Rev. 0, but it also states

that the program is implemented through AMP B2.1.8 (BWRVIP-48-A) for managing specific aging effects/mechanisms. Thus there were closely-related commitments. An example is Commitment #37 in which an enhanced visual examination, (EVT-1), of the NMP Unit 2 feedwater sparger end bracket welds will be added to NMP AMP B2.1.8. Furthermore, the attributes of the BWR Vessel ID (inside diameter) Attachment Welds Programs related to maintaining reactor coolant water chemistry are discussed in the program description for the NMP-1 "Water Chemistry Control Program" (AMP B2.1.2).

The NMP-1 audit found that during the spring 2011 refueling outage (N1R21), EVT-1 of the steam dryer support brackets revealed relevant indications (cracks or crack-like defects) in the heat-affected zone (HAZ) of three of the four brackets (made of high-C A240 Type 304 stainless steel [SS]). The cause of indications was identified as IGSCC, possibly due to residual stresses in the weld-sensitized bracket and applied dryer deadweight loads. As part of its acceptance criteria/corrective actions, the licensee recommended re-inspection during the N1R22 outage and revision of the flaw evaluation procedure to incorporate clear acceptance criteria for re-examination and to demonstrate the retention of adequate margin between N1R21 as-found indication data and the allowable criteria. If no changes in cracking are evident, then successive EVT-1 exams will be performed in subsequent outages, and if any significant change in cracking is apparent, a repair will be developed for implementation during N1R23.

4.2.4.3 Effectiveness of AMP XI.M4 to Meet Its Objective

The NRC audit report on the assessment of AMP effectiveness from the visit to NMP-1 was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.4, "AMP Worksheet XI.M4 BWR Vessel ID Attachment Welds." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.4.4.

4.2.4.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description of GALL, Rev. 2, AMP XI.M4 does not include which aging effects caused by what aging degradation mechanism are being managed by the AMP.

(b) To ensure compliance with the requirements of BWRVIP-48-A report, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP-48-A report.

The AMPs implemented by NMP-1, and by most of the BWR license renewal applicants in general, have been consistent with the GALL AMP XI.M4. Therefore, there have been no industry-proposed exceptions or enhancements to this AMP.

One good practice or strength of the AMP was identified in this review. At NMP-1 plant, the licensee's acceptance criteria/corrective actions use plant-specific OpE for updating and implementing the AMP. Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.4.3.2 Effectiveness and Implementation of AMP XI.M4

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The scope of program does not include information regarding the material of the attachment welds and their susceptibility to SCC or IGSCC in normal water chemistry (NWC) or HWC. For example, the susceptibility of Ni-alloy welds to IGSCC does not decrease and may increase in HWC.

(b) Element 2 (preventive actions) does not clarify that HWC may not have any benefit on the susceptibility of Ni-alloy welds to IGSCC.

(c) Element 3 (parameters monitored/inspected) does not clarify that the use of BWRVIP-62 guidelines for inspection relief for vessel internal components with HWC is not included in this AMP, and is approved on a case-by-case basis.

(d) Element 4 (detection of aging effects) should state clearly that all LRAs must implement the revised AMP for SLR, even those who may have implemented the Rev. 0 AMP during the current license renewal period.

(e) Element 10 (OpE) may be updated to include one NMP-1 OpE event related to cracking in the heat-affected zone (HAZ) of steam dryer brackets due to IGSCC, and the corrective actions recommended by the licensee.

4.2.4.4 Recommendations for Subsequent License Renewal

4.2.4.4.1 Good Practices or Existing Strengths of AMP XI.M4

M4.S-1: ***Recommendation*****:** An activity performed under the licensee's acceptance criteria/corrective actions of using plant-specific OpE for updating and implementing the program is considered a good practice or strength of the AMP.
Technical Basis**:** As stated in 4.2.4.2, EVT-1 of steam dryer support brackets revealed relevant indications in the HAZ. As part of its acceptance criteria/corrective actions, the applicant recommended re-inspection during the following outage and revision of the flaw evaluation procedure to incorporate clear acceptance criteria.

4.2.4.4.2 Areas of AMP XI.M4 for Further Consideration/Enhancements

Program Description:

M4.0-1: *Recommendation*: Revise the program description to include the objective of the program.
***Technical Basis*:** Although the purpose of the AMP is described in Program Element 1, "Scope of Program," the program description should include the purpose of the AMP, and state clearly that this program is focused on managing the effects of cracking due to SCC, including IGSCC in BWR vessel ID attachment welds. This is the most important component of the program description and should be clearly described in this section.

M4.0-2: *Recommendation*: Revise the program description to include guidance for licensees to address all AAIs related to the BWRVIP-48-A report referenced in the AMP.
***Technical Basis*:** The program basis document BWRVIP-48-A has AAIs associated with its NRC SER. The licensees are required to address these AAIs in Appendix C of their LRAs. Site procedures require technical justification to be documented and the NRC to be notified for any deviation from the guidelines. To ensure compliance, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP-48-A report referenced in the AMP.

1. Scope of Program:

M4.1-1: *Recommendation*: Revise the scope of program to include information regarding the material of the attachment welds and their susceptibility to SCC or IGSCC in NWC or HWC.
***Technical Basis*:** The scope of program does not specify that the material of the ID attachment welds is either SS or nickel alloy (it is typically Alloy 182). This information is very important for the mitigation actions described in Program Element 2 on preventive actions. For example, for Ni alloys, the susceptibility to SCC does not decrease and may increase in HWC compared to that in NWC.

2. Preventive Action:

M4.2-1: *Recommendation*: Revise the preventive actions program element to include clarification regarding SCC susceptibility of Ni alloys in HWC and other mitigation measures.
***Technical Basis*:** The program element states that maintaining high water purity reduces susceptibility to SCC or IGSCC. This may not be true for Ni-alloy welds; decreasing corrosion potential of the coolant environment is not beneficial for Ni alloy welds. In fact, for Ni alloys, susceptibility to SCC and fatigue crack growth rates both increase when the water corrosion potential decreases. Some other mitigation measures such as using more resistant weld metal (e.g., Alloy 82 instead of Alloy 182) or protective coatings may be included in the program.

3. Parameters Monitored/Inspected:

M4.3-1: *Recommendation*: Revise the parameters monitored/inspected program element to include some clarification for the difference between Rev. 0 and Rev. 2 of the GALL Report regarding the use of BWRVIP-62 guidelines for inspection relief for vessel internal components with HWC.
***Technical Basis*:** The guidelines of BWRVIP-62 for inspection relief were deleted from the GALL AMP in Rev. 2. For plants operating under HWC, since inspection relief under 10 CFR 50.55a(a)(3) in accordance with the guidelines of BWRVIP-62 is approved on a case-by-case basis, and only for 10 years, either BWRVIP-62 should be deleted from the reference section, or the above underlined information should be added in this program element.

4. Detection of Aging Effects:

M4.4-1: *Recommendation*: Revise the detection of aging effects program element to state clearly that all applicants must implement the GALL, Rev. 2,or later, AMP, even those who may have implemented the Rev. 0 AMP during the current license renewal period.
***Technical Basis*:** The extent and schedule of the inspection and test techniques prescribed by BWRVIP-48 guidelines in Rev. 0 and Rev. 2 of the GALL Report are the same except that the enhanced visual VT-1 examination method is considered to be capable of achieving a 1-mil wire resolution in Rev. 0 and capable of achieving a 1/2-mil (0.0005 inch) wire resolution in Rev. 2. For licensees who may have implemented the GALL, Rev. 0, AMP, it may be helpful to include some clarification that for LTO license renewal, all applicants must implement the GALL, Rev. 2, AMP.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

M4.10-1: *Recommendation*: Revise the OpE program element to include one NMP-1 OpE event related to cracking in the HAZ of steam dryer brackets due to IGSCC, and the corrective actions recommended by the licensee.
***Technical Basis*:** As noted in 4.2.4.2 EVT-1 of the steam dryer support brackets revealed cracking due to IGSCC in the HAZ of three of the four brackets (made of high-C A240 Type 304 SS). The licensee recommended specific corrective actions, which mainly consisted of continued monitoring and the use of VT-1.

4.2.5 BWR Feedwater Nozzle (XI.M5)

4.2.5.1 Objective and Scope of AMP XI.M5

The objective of this AMP is to manage the effects of cracking due to cyclic loading and its impact on the intended function of BWR feedwater nozzles. To ensure that potential detrimental effects of cracking would be adequately managed such that the intended functions of the feedwater nozzles are maintained during the PEO, the AMP relies on the following two AMAs:

(1) Enhanced ISI in accordance with (a) the requirements of the ASME Code, Section XI, Subsection IWB, Table IWB 2500-1; and (b) the recommendation of GE NE-523-A71-0594, Rev. 1, *Alternate BWR Feedwater Nozzle Inspection Requirements*. The requirements of GE NE-523-A71-0594, Rev. 1, specify UT of specific regions of the blend radius and bore. The UT examination techniques and personnel qualifications are in accordance with the guidelines of GE NE-523-A71-0594, Rev. 1. Based on the inspection method and techniques and plant-specific fracture mechanics assessments, the inspection schedule is in accordance with Table 6-1 of GE NE-523-A71-0594, Rev. 1. Leakage monitoring may be used to modify the inspection interval.

(2) The recommendations of NUREG-0619 for system modifications to mitigate cracking. These modifications include design changes such as removal of SS cladding and installation of improved spargers, and changes in plant-operating procedures such as improved feedwater control to decrease the magnitude and frequency of temperature fluctuations.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1;
(ii) GE-NE-523-A71-0594, Rev. 1, *Alternate BWR Feedwater Nozzle Inspection Requirements*; and
(iii) NUREG-0619, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking*.

4.2.5.2 Observations from NMP-1

This AMP is not applicable to Ginna, since it is a PWR. NMP-1 implements this program through its AMP B2.1.5, “BWR Feedwater Nozzle Program,” and its ISI program. It was noted during the audit that UT and dye penetrant test (PT) inspections required by NUREG-0619, as recommended by the GALL Report, have been superseded, because the inspections are now performed in accordance with ASME Code Section XI, Appendix VIII per 10 CFR 50.55a. With respect to OpE, the LRA states that NMP-1 detected significant feedwater (FW) nozzle cracking in 1977. Repairs were performed per ASME Code Case N-504-1, as endorsed by NRC Regulatory Guide (RG) 1.147, “Inservice Inspection Code Case Acceptability, ASME Section XI Division 1.”

A liquid PT examination of one FW nozzle performed in 1981 showed that no new cracks had been identified since the 1977 inspection and repairs. To minimize the potential for fatigue crack initiation, modifications meeting the requirements NUREG-0619 (including cladding removal, improved thermal sleeve/FW sparger design, rerouting of reactor water cleanup piping to the FW line, and improved FW flow control) were completed for the NMP-1 FW system. A series of calculations was performed to evaluate stress, fatigue usage factor, and crack growth of an assumed flaw projected to the end of life of the plant (40 years) as a function of number of operating cycles; these analyses formed the basis for the enhanced ISI program for the FW nozzle implemented at NMP-1. During the 1999 refueling outage (RFO15), an inservice UT of the four FW nozzles discovered no reportable indications. Visual examinations of the feedwater

sparger as per NUREG-0619, performed in 2005 (RFO18) in accordance with NMPNS procedures, identified no recordable indications. Subsequently in 2007 (RFO19), welds were ultrasonically examined and were found acceptable. The next UT examination of the welds is scheduled to be performed during RFO 24.

In 1999, the original stress, fatigue, and crack growth analyses were revised to meet the requirement to use the updated ASME code fatigue curves and to incorporate changes in fatigue cycle definitions (magnitude and frequency of load cycles) based on updated plant data assumptions. These calculations include assumptions on numbers of transients occurring over a 1-year period, and a determination of the low-cycle fatigue usage factor for the FW system nozzles. Based on an anticipated number of startup/shutdown/scram cycles per year, annual fatigue usage factor was calculated to be 0.003 per year.

4.2.5.3 Effectiveness of AMP XI.M5 to Meet Its Objective

The audit report on the assessment of AMP effectiveness from the visit to NMP-1 was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the "program description" and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.5, "AMP Worksheet XI.M5 BWR Feedwater Nozzle." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical bases, and the related section in the GALL report and/or SRP are listed in Subsection 4.2.5.3.

4.2.5.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not include a statement that the inspection requirements of NUREG-0619 have been superseded by the guidance of GE-NE-523-A71-0594, Rev. 1.

(b) The program description does not include the objective of the program.

(c) The program description does not identify the significance of the two basis or supporting documents, GE NE-523-A71-0594, Rev. 1 and NUREG-0619.

(d) The program description does not provide guidance for plants that have committed to inspection requirements of ASME Code editions before 1995.

The AMPs implemented by NMP-1, and by most of the BWR license renewal applicants in general, have been consistent with GALL AMP XI.M5. However, the older plants have made an exception and committed to inspection requirements based on ASME Code editions earlier than 1995. Therefore, there have been some industry-proposed exceptions to this AMP.

No good practices or strengths of the AMP were identified in this review. In addition, information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.5.3.2 Effectiveness and Implementation of AMP XI.M5

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The preventive actions program element does not include mitigation actions from NUREG-0619 regarding system modifications and changes in plant operating procedures.

(b) Since the inspection guidance in NUREG-0619 is not implemented in this AMP, the parameters monitored/inspected program elements should remove any reference to this document.

(c) The detection of aging effects program element does not include a statement that if plant-specific fracture mechanics assessments are used to define inspection guidance, these analyses should be updated to be consistent with the recent Codes and standards and include the effects of any plant modification such as EPU.

(d) The acceptance criteria program element does not provide a statement that to meet the requirements of AAIs associated with the NRC SER for BWRVIP-74-A, fatigue crack growth and CUF analyses, including environmental effects, should be updated.

4.2.5.4 Recommendations for Subsequent License Renewal

4.2.5.4.1 Good Practices or Strengths of AMP XI.M5

No specific good practice was identified during the review.

4.2.5.4.2 Areas of AMP XI.M5 for Further Consideration/Enhancements

Program Description:

M5.0-1: *Recommendation*: Revise the program description to add a statement that the plant-specific inspection requirements of NUREG-0619 may have been superseded by the guidance of GE-NE-523-A71-0594, Rev. 1.
***Technical Basis*:** Although the program description item (c) states that NUREG-0619 recommendations are for system modifications to mitigate cracking, the parameters monitored/inspected program element states, “this AMP monitors for cracking due to cyclic loading and its impact on the intended function of the BWR feedwater nozzle by detection and sizing of cracks by ISI in accordance with ASME Code, Section XI, Subsection IWB; the recommendation of GE NE-523-A71-0594, Rev. 1; and NUREG-0619 recommendations.” It would be prudent to clarify that UT and liquid penetration test (PT) inspections required by NUREG-0619 have been superseded by the guidance of GE-NE-523-A71-0594, Rev. 1, and that inspections are now performed in accordance with this document and ASME Section XI, Appendix VIII.

M5.0-2: *Recommendation*: Revise the program description to include the objective of the program.

***Technical Basis*:** The program description for XI.M5 AMP in Rev. 2 of the GALL Report does not include the objective of the program (i.e., which aging effects caused by what aging degradation mechanisms are being managed by this AMP). It does not state that this AMP manages cracking of the BWR feedwater nozzles due to cyclic loading. This is the most important component of the program description and should be clearly described in this section.

M5.0-3: *Recommendation*: Revise the program description to clearly identify the significance of the two basis or supporting documents, GE NE-523-A71-0594, Rev. 1 and NUREG-0619.
***Technical Basis*:** The alternative BWR feedwater nozzle inspection requires a demonstration that the UT method to be used is capable of detecting and sizing flaws with depths of 0.25 inch and greater, which meets the objectives of ASME Section XI, Appendix VIII. This assurance eliminates the need for the PT examination that was originally required in NUREG-0619 due to the lack of confidence in UT techniques at the time that NUREG-0619 was published. Furthermore, the inspection frequencies are based on the examination results, type of UT examination, sparger type, and the results of a plant-specific fracture mechanics assessment. For consistency in the implementation of the AMP, it would be helpful if the specific guidance in these two documents were clearly identified in the program description.

M5.0-4: *Recommendation*: Revise the program description to include clear guidance for plants that have committed to the inspection requirements of ASME Code editions before 1995.
***Technical Basis*:** A significant deficiency in the inspection program proposed in the GALL AMP XI.M5 is the lack of guidance regarding the use of earlier editions of the ASME Section XI Code. Chapter 1 of Rev. 2 of the GALL Report states, "the following ASME Section XI editions and addenda are acceptable and should be treated as consistent with the GALL Report: (1) from the 1995 edition to the 2004 edition, as modified and limited in 10 CFR 50.55a, and (2) more recent editions, as evaluated for their adequacy for license renewal and discussed in the accompanying FRN for 10 CFR 50.55a rulemaking endorsing those specific editions." However, the NMP-1 AMP B2.1.5 for the BWR feedwater nozzle consists of augmented examinations through the ISI Program, which is based on the 1989 edition of the ASME Section XI Code. Although the exception regarding the 1989 edition of the Code is not significant, the program description should be updated to include some guidance for plants that committed to the inspection requirements of editions of the ASME Code before 1995, at the time of LRA approval.

1. <u>Scope of Program</u>:

No further review items were identified.

2. <u>Preventive Action</u>:

M5.2-1: *Recommendation*: Revise the preventive actions program element to include mitigation actions.
***Technical Basis*:** The description of the preventive actions program element of this AMP states that this program is a condition monitoring program and has no preventive actions. This statement is misleading. As described in the program description above, this AMP has two AMAs, (a) enhanced ISI in accordance with the requirements of ASME Section XI, Subsection IWB and the recommendations of GE-NE-523-A71-0594, Rev. 1; and (b) mitigation measures documented in NUREG-0619. Measures to mitigate cracking include systems modification such as removal of SS cladding and installation of improved spargers, and changes to plant-operating procedures, such as improved feedwater control to decrease the magnitude and frequency of temperature fluctuations. The preventive actions program element should be

revised to include mitigation actions that may have been taken at the plant, or may be taken in the future should the need arise.

3. <u>Parameters Monitored/Inspected</u>:

M5.3-1: *Recommendation*: Revise the parameters monitored/inspected program element to remove any reference to NUREG-0619 in this program element.
***Technical Basis*:** If the recommendations of NUREG-0619 are only related to mitigation activities, any reference to recommendations in NUREG-0619 in this program element may cause confusion. If the NUREG-0619 recommendations are not invoked for monitoring or inspection to detect cracking, it would be helpful to remove any reference to NUREG-0619 in this program element to avoid confusion.

4.<u>Detection of Aging Effects</u>:

M5.4-1: *Recommendation*: Revise the detection of aging effects (and maybe monitoring and trending) program element to include a statement that if plant-specific fracture mechanics assessment is used to define inspection guidance, these analyses should be updated to be consistent with the recent Codes and standards and include the effects of any relevant plant modification such as EPU.
***Technical Basis*:** As mentioned above in recommendation M5.0-3, the inspection frequencies are based on the examination results, type of UT examination, sparger type, and the results of a plant-specific fracture mechanics assessment. As part of the license renewal, these licensing basis fracture mechanics assessments should be updated to be consistent with the recent Codes and standards, in particular the most recent expressions for crack growth rates, including the effects of the reactor coolant environment. These analyses should also be updated to include the effects of any plant modification such as EPU, which can change the heat balance of the primary system (temperature, pressure, flow, and steam quality).

5. <u>Monitoring and Trending</u>:

No further review items were identified.

6. <u>Acceptance Criteria</u>:

M5.6-1: *Recommendation*: Revise the acceptance criteria program element to ensure that fatigue crack growth and CUF analyses, including environmental effects, are updated.
***Technical Basis*:** There are 14 AAIs associated with the NRC SER for BWRVIP-74-A. AAI #8 states that the license renewal (LR) applicant should verify that the number of cycles assumed in the original fatigue design is conservative to assure that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, a LR applicant must address environmental fatigue for the components listed in BWRVIP-74-A for the license period. These components or locations include nozzles and safe-ends.

7. <u>Corrective Actions</u>:

No further review items were identified.

8. <u>Confirmation Process</u>:

No further review items were identified.

9. <u>Administrative Controls</u>:

No further review items were identified.

10. <u>Operating Experience</u>:

No further review items were identified.

4.2.6 BWR Control Rod Drive Return Line Nozzle (XI.M6)

4.2.6.1 Objective and Scope of AMP XI.M6

The objective of this AMP is to manage the effects of cracking due to thermal fatigue and its impact on the intended function of the BWR control rod drive return line (CRDRL) nozzle. This program is also intended to address SCC discussed in NRC IN 2004-08. The program is applicable to BWRs whose reactor vessel design includes a CRDRL nozzle. The scope of the program includes CRDRL nozzles and their nozzle-to-reactor-vessel welds, and if an applicant has cut the piping to the CRDRL nozzle and capped the CRDRL nozzle, the program scope includes the CRDRL nozzle cap and associated nozzle-to-cap weld.

To ensure that potential detrimental effects of cracking would be adequately managed such that the intended functions of the CRDRL nozzle is maintained during the PEO, the AMP relies on the following two AMAs:

(1) ISI in accordance with (a) the requirements of the ASME Code, Section XI, Subsection IWB, Table IWB 2500-1; and (b) augmented inspection in accordance with applicant's commitments to NRC Generic Letter (GL) 80-095 to implement the recommendations in NUREG-0619. Recommendations include PT of CRDRL nozzle inner blend radius and bore regions and the reactor vessel wall area beneath the nozzle, CRD system performance testing, and for capped nozzles, the nozzle cap and cap-to-nozzle weld. The inspection is to include the base metal to a distance of one-pipe-wall thickness or 0.5 inches, whichever is greater, on both sides of the cap-to-nozzle weld. Later GL 88-11 was issued to provide additional clarification on the contents of the confirmatory response requested in GL 80-095.

(2) Activities for preventing or mitigating cracking in CRDRL nozzles are consistent with a BWR facility's past preventive or mitigation actions/activities in its CLB as stated in the applicant's docketed response to GL 80-095 and GL 88-11, and made to address the recommendations in NUREG-0619. In addition, to reduce susceptibility to SCC, reactor coolant water chemistry is monitored and maintained in accordance with the GALL AMP XI.M2, Water Chemistry Program.

Background Information NRC IN 2004-08

During the 2003 fall inspection at the Pilgrim Station, a through-wall crack was discovered in the nozzle-to-cap weld of the CRDRL nozzle N10. The crack was completely contained within the weld and considered to be due to interdentritic SCC. In 1977, to prevent cracking due to thermal fatigue resulting from the return of cooler water to the reactor vessel from the CRD system, the licensee modified the N10 nozzle by cutting and isolating the existing CRD system to nozzle N10, rerouting the CRD return line to the CRD cooling water header, and removing the safe end and thermal sleeve from nozzle N10 and installing an Alloy 600 cap. In accordance with BWRVIP-75, the N10 nozzle was classified as a Category D weld, meaning that it is made of susceptible materials that have not been treated with an IGSCC remedy and in which cracks have not been reported. Prior to the 2003 inspection, the N10 nozzle-to-cap weld was last inspected during the spring 1999 refueling outage. After the qualified examination of the CRDRL nozzle weld during the 2009 outage, future inspections will be in accordance with the schedule for Category E welds, meaning those that have weld overlay repairs made with an IGSCC-resistant, Ni alloy (e.g., Alloy 52) and have received one qualified ISI since the initial post-overlay examination.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1;
(ii) NUREG-0619, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking*; and
(ii) BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines – 2008 Revision*.

4.2.6.2 Observations from NMP-1

This AMP is not applicable to Ginna, since it is a PWR. NMP-1 implements this program through its AMP B2.1.37, "BWR Control Rod Drive Return Line Nozzle Program." The NMP-1 LRA states that this program is consistent with AMP XI.M6 of the GALL Report, Rev. 0, with three exceptions. Further details are available in the AMP Effectiveness Audit Summary TLR, ML13122A009.

A CRDRL nozzle crack growth fracture mechanics analysis was used to demonstrate the adequacy of the 10 year inspection frequency. The NRC staff noted that, since the fracture mechanics analysis may form a basis for establishing the nozzle reinspection interval, it should be re-visited accordingly.

It was noted during the audit that no cracking was found during PT examinations of the NMP-1 CRDRL nozzle in 1977 or during subsequent examinations. During RFO15, an inservice UT of the CRDRL nozzle discovered no reportable indications (attachment to letter from Niagara Mohawk Power Corporation (NMP-1L 1489) to NRC dated December 13, 1999). A welded-in-place thermal sleeve design makes the NMP-1 CRDRL nozzle less susceptible to thermal fatigue cracking than the original designs at other BWRs. In 1994, an analysis evaluating crack growth for an assumed flaw in the CRDRL nozzle showed that small surface flaws would not grow to unacceptable values within the original 40-year license period.

The CRD return line safe-end and the thermal sleeve were replaced in 1978 with modified design to improve resistance to both IGSCC and fatigue cracking. The replacement thermal sleeve material is low-carbon Type 316L SS, and the thermal sleeve is welded to the safe-end with low-carbon Type 308L weld filler. To reduce the probability of fatigue cracking, the thermal sleeve pipe protrudes 7 inches from the flow shield, which promotes mixing away from the vessel wall, thus preventing thermal cycling at the vessel wall and at the flow shield.

4.2.6.3 Effectiveness of AMP XI.M6 to Meet Its Objective

The audit report on the assessment of AMP effectiveness from the visit to NMP-1 was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.6, "AMP Worksheet XI.M6 BWR CRD Return Line Nozzle." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.6.4.

4.2.6.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not include the objective of the program.

(b) The program description does not include mitigation measures in accordance with the recommendations in NUREG-0619 and the GALL AMP XI.M2, Water Chemistry Program.

(c) The program description does not include clear guidance regarding the augmented inspection program that is being recommended.

The AMPs implemented by NMP-1, and by most of the BWR license renewal applicants in general, have been consistent with the GALL AMP XI.M6. Therefore, there have been no industry-proposed exceptions or enhancements to this AMP.

No good practices or strengths of the AMP were identified in this review. In addition, information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.6.3.2 Effectiveness and Implementation of AMP XI.M6

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The detection of aging effects and monitoring and trending program elements do not include a statement that if plant-specific fracture mechanics assessments are used to define inspection guidance, these analyses should be updated to be consistent with the recent Codes and standards and include the effects of any plant modification such as EPU.

(b) The acceptance criteria program element does not provide a statement that to meet the requirements of AAIs associated with the NRC SER for BWRVIP-74-A, fatigue crack growth and CUF analyses, including environmental effects, should be updated.

4.2.6.4 Recommendations for Subsequent License Renewal

4.2.6.4.1 Good Practices or Strengths of AMP XI.M6

No specific good practice was identified during the review.

4.2.6.4.2 Areas of AMP XI.M6 for Further Consideration/Enhancement

<u>Program Description</u>:

M6.0-1: *Recommendation*: Revise the program description to include the objective of the program.
***Technical Basis*:** The program manages crack initiation and growth due to cyclic loading or SCC in the CRDRL nozzle. However, the program description does not describe clearly which

aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the most important component of the program description and should be clearly included in this section.

M6.0-2: *Recommendation*: Revise the program description to include mitigation measures in accordance with the recommendations in NUREG-0619 and by implementing the GALL AMP XI.M2, Water Chemistry Program
***Technical Basis*:** The program description for XI.M5 AMP in Rev. 2 of the GALL Report states that, in this AMP, augmented inspections performed in accordance with the recommendations in NUREG-0619 supplement those ISIs required for these nozzles in accordance with the ASME Code, Section XI, Table IWB-2500-1, as mandated through reference in 10 CFR 50.55a. However, the program description does not include the mitigation measures described in Program Element 2 involving the guidance in NUREG-0619 and water chemistry control to reduce susceptibility to SCC.

M6.0-3: *Recommendation*: Revise the program description to include clear guidance regarding the augmented inspection program being recommended.
***Technical Basis*:** The NMP-1 LRA states that inspection recommendations in NUREG-0619 have been superseded because the inspections are now performed in accordance with ASME Section XI Appendix VIII, which suggests that NMP-1 has invoked alternate rules that supersede those contained in NUREG-0619. It is unclear whether the requirements of NUREG-0619 were invoked, or whether alternative inspections are being performed and NUREG-0619 is being used as guidance. Depending on which requirements apply the program description may need to be revised to clarify that the UT and PT inspections required by NUREG-0619 have been superseded by the alternative inspection guidance, and that augmented inspections are now performed in accordance with ASME Section XI, Appendix VIII.

1. <u>Scope of Program</u>:

No further review items were identified.

2. <u>Preventive Action</u>:

No further review items were identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review items were identified.

4. <u>Detection of Aging Effects</u>:

M6.4-1: *Recommendation*: Revise the detection of aging effects (and maybe monitoring and trending) program element to include a statement that if a plant-specific fracture mechanics assessment is used to define inspection guidance, the analysis should be updated to be consistent with the recent Codes and standards and include the effects of any plant modification such as EPU.
***Technical Basis*:** The CRDRL nozzle program requires augmented inspection of the nozzles in accordance with the recommendations of NUREG-0619, and a crack growth fracture mechanics analysis is used to demonstrate the adequacy of the inspection interval (i.e., a postulated flaw will not grow to unacceptable size until the next inspection of the BWR CRDRL nozzle). As part of the license renewal, this licensing basis fracture mechanics assessment may need to be

updated to be consistent with the recent Codes and standards, in particular the most recent expressions for crack growth rates, including the effects of reactor coolant environment. In addition, these analyses may also need to be updated to include the effects of any plant modification such as EPU, which can change the heat balance of the primary system (temperature, pressure, flow, and steam quality).

5. Monitoring and Trending:

No further review items were identified.

6. Acceptance Criteria:

M6.6-1: *Recommendation*: Revise the acceptance criteria program element to ensure that fatigue crack growth and CUF analyses, including environmental effects, are updated.
***Technical Basis*:** There are 14 AAIs associated with the NRC SER for BWRVIP-74-A. AAI #8 states that the LR applicant should verify that the number of cycles assumed in the original fatigue design is conservative to assure that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, a LR applicant must address environmental fatigue for the components listed in BWRVIP-74-A for the license period. These components or locations include nozzles and safe-ends.

7. Corrective Actions:

No further review items were identified.

8. Confirmation Process:

No further review items were identified.

9. Administrative Controls:

No further review items were identified.

10. Operating Experience:

No further review items were identified.

4.2.7 BWR Stress Corrosion Cracking (XI.M7)

4.2.7.1 Objective and Scope of AMP XI.M7

The objective of this AMP is to manage the SCC or IGSCC of austenitic SS and nickel alloy components, and associated welds in the reactor coolant system of BWRs. The AMP is also credited for managing SCC or IGSCC in ECCS and shutdown cooling system piping with treated water (at greater than 60°C). In addition to the piping components, the AMP addresses pump casings, valve bodies, and reactor vessel attachments and appurtenances, such as head spray, CRD return lines and vent components. Furthermore, the program also applies to and includes austenitic SSs with less than 0.035 carbon content, which have been labeled IGSCC-resistant materials. The scope of this AMP is not to any particular Code classification of these components or welds.

This AMP is primarily based on the program delineated in NUREG-0313, Rev. 2, and GL 88-01 and its Supplement 1, which provide the technical basis and Staff guidance regarding inspections and mitigation of SCC in BWRs. BWRVIP-75-A provides the basis for alternative inspection requirements to the extent and frequency guidance of GL 88-01, for welds in certain categories. The applicability of these reduced inspections may need to be evaluated on a plant-specific basis to ensure that the conditions of the BWRVIP-75-A report basis are satisfied, such as the effectiveness of any stress improvement and HWC implementation at the plant.

The BWR SCC AMP takes credit for and is associated with AMP XI.M2 for water chemistry controls.

To ensure potential aging degradation due to SCC and IGSCC of BWR components in the scope of this AMP will be adequately managed such that their intended functional integrity is maintained during the PEO, the AMP relies on three AMAs: (i) ISI specifically for the SCC/IGSCC, with qualified examinations; (ii) mitigation efforts to reduce the potential or susceptibility for SCC/IGSCC; and (iii) any needed flaw evaluation with corrective action of repair or replacement.

For these AMAs, the AMP relies on the requirements or guidance from the following documents:
(i) USGL 88-01 with its Supplement, and NUREG-0313, Rev. 2;
(ii) approved BWRVIP-75-A report for additional guidance or alternative requirements;
(iii) ASME Section XI ISI as per 10 CFR 50.55(a), but meeting GL 88-01 and BWRVIP-75-A; and
(iv) ASME Section XI, Subsections IWA-3000 for flaw evaluation and IWA-4000 for corrective action; part of this evaluation may use guidance from an approved BWRVIP report (BWRVIP-14-A, BWRVIP-59-A, BWRVIP-60-A, BWRVIP-61, and BWRVIP-62).

4.2.7.2 Observations from NMP-1

This AMP is not applicable to Ginna, since it is a PWR. NMP-1 implements this program through its AMP B2.1.6, “BWR Stress Corrosion Cracking Program.”

A review of the licensee’s program self-assessment reports indicates that the HWC system may not be meeting industry goals for HWC control. Further discussion of the licensee’s actions to address this is provided in Section 2.3.2, “XI.M2 Water Chemistry,” of the AEA TLR (ML13122A009).

NMP-1 OpE in general indicates that sulfate spikes occurred in the reactor coolant system due to resin release (intrusions) from demineralizers. High sulfate levels have the potential to significantly accelerate SCC of BWR piping during and subsequent to such intrusions. If demineralizer resin intrusions occur repeatedly and their effects are allowed to accumulate, the effects on aging can be significant over the current and subsequent PEOs. After the audit, the licensee provided the information that NMP-1 installed iron pre-filters which has significantly reduced the frequency of resin intrusions/sulfate transients.

The AMP was successful in detecting cracks from the welds within the scope of the program. The licensee also concluded that after successive examinations of the flaws in the recirculation system, the geometry and the size of the flaws had not changed essentially from the previous examination results. Therefore, the licensee has concluded that the flaws are not due to SCC, but fabrication-related.

4.2.7.3 Effectiveness of AMP XI.M7 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.7, “AMP Worksheet XI.M7 BWR Stress Corrosion Cracking.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.7.4.

4.2.7.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The description does not address (i) managing of SCC or IGSCC in ECCS and shutdown cooling system piping with treated water (at greater than 60°C), as credited for this AMP, in the related AMR items; and (ii) austenitic SSs that have less than 0.035 carbon content – but are required to be inspected.

(b) The GALL AMP does not note or provide any guidance regarding the precedence and differences between the inspection requirements of ASME Section XI Code, GL 88-01, and the guidelines in BWRVIP-75-A.

(c) The description of GALL AMP XI.M7 does not clearly define its interface and supplementing role with two other AMPs: XI.M2 (Water Chemistry) and XI.M9 (BWR Vessel Internals) related to IGSCC.

(d) The GALL AMP references several BWRVIP reports that deal with the IGSCC of reactor vessel internals. However, the program description does not provide a clear indication as to the applicability (coverage) of guidance from these reports.

4.2.7.3.2 Effectiveness and Implementation of AMP XI.M7

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," does not include SCC/IGSCC of other safety-related systems (e.g., ECCS, RHR, and shutdown cooling) and treated water environment (at greater than 60°C), and does not clarify the difference in coverage for BWR vessel internals between this AMP and GALL XI.M9 AMP.

(b) Program Element 2, "Preventive Actions," is generally not consistent with the AMP description and the emphasis of industry actions that have been focused on implementing mitigation measures which, although not strictly guaranteed to prevent the IGSCC, are intended to be preventive in nature.

(c) Program Element 4, "Detection of Aging Effects, does not convey the emphasis needed for examinations to be qualified for the detection of IGSCC and that the modifications to the extent and scheduling of inspections under BWRVIP-75-A are limited only to a subset of welds and only under specifically demonstrated effectiveness of mitigative measures that may be plant-specific.

(d) Program Element 10, "Operating Experience," may need further assessment to verify the long-term effectiveness of countermeasures that have been credited for the reduced scope and frequency of inspections going into the PEO.

4.2.7.4 Recommendations for Subsequent License Renewal

4.2.7.4.1 Good Practices or Strengths of AMP XI.M7

No specific good practice was identified during the review.

4.2.7.4.2 Areas of AMP XI.M7 for Further Consideration/Enhancement

Program Description:

M7.0-1: *Recommendation*: Include in the AMP description that it also manages SCC or IGSCC in the ECCS and shutdown cooling system piping with treated water (at greater than 60°C), and replace references to "sensitized" material or "sensitization" with "susceptible" material or "susceptibility," and delete any reference to 0.035 weight percent carbon content.
***Technical Basis*:** Several AMR items credit this AMP for managing SCC or IGSCC in ECCS and shutdown cooling system piping with treated water (at greater than 60°C). The term "susceptible" material is preferred because it covers the IGSCC in non-sensitized materials including nickel-based alloys, and the inspection requirements include austenitic SSs with less than 0.035 weight percent carbon content.

M7.0-2: *Recommendation*: Clarify or provide guidance as to which set of requirements are overriding when multiple documents are applicable or considered, such as the ASME Section XI Code, regulatory position in GL 88-01, any Code Cases, and/or the industry guidelines in BWRVIP-75-A.
***Technical Basis*:** Conditions or basis assumptions for applicability of various differing sets of

requirements are different and need confirmation that may be plant-specific. A uniform or consistent use of differing requirements with clearly stated precedence would be necessary to avoid missing or confounding their application, which would otherwise be important.

M7.0-3: *Recommendation*: Clarify (i) the AMP interface and supplementing role with two other AMPs, XI.M2 (Water Chemistry) and XI.M9 (BWR Vessel Internals), related to the IGSCC; and (ii) the role of several referenced BWRVIP reports that deal with the IGSCC of reactor vessel internals.
***Technical Basis*:** Since the objectives and implementation of the AMPs XI.M2 and XI.M9 differ in many ways compared to this AMP, it is necessary to know which components and implemented mitigation measures are best checked or evaluated under which of these AMPs.

1. <u>Scope of Program</u>:

M7.1-1: *Recommendation*: Include SCC/IGSCC of other safety-related systems (e.g., ECCS, RHR, and shutdown cooling) and treated water environment (at greater than 60°C) in the program scope, and clarify or provide guidance with regard to various vessel internals (including welds and attachments) to be addressed in this AMP vis-à-vis those covered under the GALL XI.M9 AMP. In addition, include program interface with the reactor water cleanup (RWCU) system and maintain the scope's current inclusion of components and welds without regard for their Code classification (i.e., restate that the AMP scope is not limited by any Code classification).
***Technical Basis*:** Several AMR items take credit for this AMP, in which the systems and environments do not match those in the as-described scope, and requirements or bases for vessel internals under XI.M9 may differ from this AMP so that the components to be scoped under the two programs need to be uniquely and appropriately assigned to these AMPs.

M7.1-2: *Recommendation*: If the scope of program is altered on a plant-specific level from that outlined in GALL AMP basis documents, with alternate inspections and/or IGSCC countermeasures, then these alterations or deviations in the scope and their bases should be listed in the LRA.
***Technical Basis*:** The guidance provided in multiple basis documents of this AMP can result in program scopes significantly different from plant to plant and from that originally recommended, over a long period of time. To assess the effectiveness and for industry-wide comparison of AMP implementation over the PEO it would be useful to have a track record of such changes and their basis available as part of the updated LRA documentation.

2. <u>Preventive Action</u>:

M7.2-1: *Recommendation*: Make the element description consistent with the program description and the underlying intent of several countermeasures to note that the program includes preventive actions in addition to the inspection-based monitoring of the SCC/IGSCC aging effect.
***Technical Basis*:** The AMP guidance and major industry efforts to manage the SCC/IGSCC have focused on implementing mitigation measures that, although not strictly guaranteed to prevent SCC, are preventive in nature for the long term. In either case, the description should be consistent with other elements of this AMP.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M7.4-1: *Recommendation*: Emphasize the need for examinations to be qualified for the detection of IGSCC and that any modifications to the extent and scheduling of inspections under BWRVIP-75-A are limited only to a subset of welds and only under specifically demonstrated effectiveness of mitigative measures that may be plant-specific. Recommend that an enhanced method of IGSCC detection is desirable, especially when considering LTOs in conjunction with the adoption of reduced scope and frequency of inspections.
***Technical Basis*:** The AMP basis documents GL 88-01 and approved BWRVIP-75-A report do note that the detection of cracking is based on well-qualified techniques and personnel specifically for the IGSCC as observed in the past OpE. In addition, while the basis documents continue to provide the best available guidance on IGSCC management, it is essential for future OpE to confirm continued effectiveness for operating periods beyond 60 years. An enhanced inspection program for detection of IGSCC may be required to verify this for adequate management and timely detection of IGSCC during the PEO.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M7.10-1: *Recommendation*: The AMP should include further assessment to verify the long-term effectiveness of countermeasures that have been credited for the reduced scope and frequency of inspections going into the PEO. This is likely to be plant-specific because of the varied nature and operating conditions of implementing the countermeasures. Also for these reasons, guidance should be provided for documenting with a track record of changes implemented, their basis, and confirmation process.
***Technical Basis*:** To evaluate this AMP for a subsequent renewal period would require a plant-specific assessment of the preventive actions taken by the applicant. For example, preventive measures at Columbia included the use of materials resistant to SCC for component replacement or repairs in accordance with the guidance of GL 88-01, and induction heating stress improvement (IHSI) process for piping welds and mechanical stress improvement process (MSIP) for nozzle-to-safe-end or safe-end-to-pipe welds. Cooper has also taken similar actions for replacement components; however, instead of using GL 88-01 to determine the

scope of welds selected for examination, a risk-informed methodology (approved by the NRC) was used as the basis. For each plant, an assessment of such preventive actions or changes incorporated (especially during the period after the LRA) should be performed for subsequent renewal period, which would require a comprehensive list and track record of such actions taken during the life of the plant.

M7.10-2: *Recommendation*: Survey the industry-wide experience with HWC availability and assess its impact as a countermeasure for managing the IGSCC under this AMP for extended and LTOs.
***Technical Basis*:** Review of some program self-assessment reports indicates that an HWC system may not be meeting industry goals for its operability and that the HWC system design changes to enable low-power hydrogen injection may not be receiving deserved or desired attention. In addition, the long-term strategy for ECP monitoring and coupons may need better coordination between chemistry, systems, and design groups/programs. The low-power HWC injection capability to improve the HWC availability may be a critical long-term strategic initiative, particularly relatively short periods of HWC unavailability are expected to allow pre-existing indications to grow even after the hydrogen level is returned to service. This limited availability of HWC during certain operating conditions can lower the potential mitigation effect during the PEO or LTOs.

M7.10-3: *Recommendation*: As part of the OpE assessment, emphasize the importance of sulfate chemistry control in the GALL Report, and need for added attention to the sulfate levels. Consider including a plant-specific program for demineralizer chemistry control and maintenance as part of the BWR Water Chemistry AMP.
***Technical Basis*:** The plant OpE in general indicates the presence of sulfate spikes due to resin release (intrusions) from demineralizers. High sulfate levels have the potential to significantly accelerate SCC of BWR piping during and subsequent to such intrusions. Cumulative effects of these intrusions can be significant over the PEO and LTOs. Demineralizer resin intrusion can also increase sulfate levels in the reactor coolant and treated water.

4.2.8 BWR Penetrations (XI.M8)

4.2.8.1 Objective and Scope of AMP XI.M8

The objective of this AMP is to manage the effects of cracking due to cyclic loading and SCC or IGSCC and its impact on the intended function of BWR penetrations. The scope of the program includes BWR instrumentation penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR standby liquid control (SLC) nozzles/Core ΔP nozzles. To ensure that potential detrimental effects of cracking would be adequately managed such that the intended functions of the BWR penetrations are maintained during the PEO, the AMP relies on the following two AMAs:

(1) Inspection and flaw evaluation in conformance with the guidelines of Staff-approved BWRVIP Reports BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A. The guidelines of BWRVIP-49-A provide information on the type of instrument penetration, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-47-A provide information on components located in the lower plenum region, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-27-A are applicable to plants in which the SLC system injects sodium pentaborate into the bottom head region of the vessel (in most plants, as a pipe within a pipe of the core plate ΔP monitoring system). The BWRVIP-27-A guidelines address the region where the ΔP and SLC nozzle or housing penetrates the vessel bottom head and include the safe ends welded to the nozzle or housing. Guidelines for repair design criteria are provided in BWRVIP-57-A for instrumentation penetrations and BWRVIP-53-A for SLC lines.

(2) To reduce susceptibility to SCC or IGSCC, reactor coolant water chemistry is monitored and maintained in accordance with industry guidelines, such as BWRVIP-190 or later revisions. BWRVIP-190 has three sets of guidelines: one for primary water, one for condensate and feedwater, and one for CRD mechanism cooling water.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1;
(ii) BWRVIP-49-A (EPRI 1006602), *BWR Vessel and Internals Project, Instrument Penetration Inspection and Flaw Evaluation Guidelines*;
(iii) BWRVIP-47-A (EPRI 1009947), *BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines*;
(iv) BWRVIP-27-A (EPRI 1007279), *BWR Vessel and Internals Project, BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines*;
(v) BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines-2008 Revision*; and
(vi) ASME Section XI, Subsections IWA-3000 for flaw evaluation and IWA-4000 for corrective action; and the guidance of BWRVIP-53-A and BWRVIP-57-A for repair design criteria and BWRVIP-14-A, BWRVIP-59-A, BWRVIP-60-A, BWRVIP-61, BWRVIP-62, BWRVIP-99-A, and BWRVIP-100-A reports for performing flaw tolerance and growth analyses.

4.2.8.2 Observations from NMP-1

This AMP is not applicable to the Ginna because it is a PWR. Further details regarding the NMP-1 program are included in the AEA TLR, ML13122A009.

During the NMP-1 audit, the staff noted that, based on the BWRVIP-27 guidance, the licensee's program for the penetration-to-safe-end weld of the core differential pressure and standby liquid control (ΔP/SLC) nozzles with stainless steel safe ends recommends an enhanced VT-2 inspection until a qualified UT is available. Furthermore, the feasibility of an appropriate volumetric examination for the ΔP/SLC nozzle locations is being evaluated.

The NMP-1 OpE indicates that the Unit 1 CRD stub tubes have experienced IGSCC cracking due to furnace-sensitized austenitic stainless steel fabrication. The licensee indicated that the system leakage test per the ASME code is performed during every refueling outage, and "best effort inspections" are performed for the stub tubes because they are not accessible during the normal refueling outage activities. During the last 18 years of operation, cracks and leakage have been detected in the CRD stub tubes using EVT-1 and VT-2 examinations, respectively. The exception was stub tube 50-19 in which EVT-1 did not identify cracking even though VT-2 examination had detected leakage from the stub tube.

Repairs of the cracked or leaking stub tubes have been made by roll expanding the CRD housing. The licensee stated that following roll repairs, a zero leakage condition has been observed in all cases. To date, 33 CRD penetrations have been roll expanded to a nominal 4 percent wall thinning. Of these, only one penetration (50-19) has been re-roll expanded to 6 percent wall thinning due to repeated occurrence of leakage. No leakage has been observed at this penetration since it was last roll expanded in 2005.

In relation to the implementation of HWC, the staff noted that the licensee's July–September 2011 program health report for the BWR Water Chemistry Program indicated that the HWC system was not meeting the industry goal of 98 percent availability. Further discussion of the licensee's actions to address this is provided in Section 2.3.2, "XI.M2 Water Chemistry," in ML13122A009.

4.2.8.3 Effectiveness of AMP XI.M8 to Meet Its Objective

The audit report on the assessment of AMP effectiveness from the visit to NMP-1 was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant AMP audits and its assessment are included in Appendix Subsection A.8, "AMP Worksheet XI.M8 BWR Penetrations." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical bases, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.8.4.

4.2.8.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not include the objective of the program.

(b) The program description does not state that license renewal applicants should address all AAIs related with BWRVIP reports referenced in the AMP.

(c) The program description (and detection of aging effects) does not clarify the differences in the AMP described in GALL, Rev. 0, and GALL, Rev. 2.

The AMPs implemented by NMP-1, and by most of the BWR license renewal applicants in general, have been consistent with the GALL AMP XI.M8. Therefore, there have been no industry-proposed exceptions or enhancements to this AMP.

One good practice or strength of the AMP was identified in this review. The corrective actions, root cause analyses performed by NMP-1 plant to resolve the stub tube cracking, and preemptive actions to develop alternative weld repair techniques, are considered good practices or strengths of the AMP. Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.8.3.1 Effectiveness and Implementation of AMP XI.M8

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The scope of program does not define the material of the BWR penetrations and associated welds.

(b) The preventive actions program element does not include clarification regarding SCC susceptibility of Ni alloys in HWC and NWC BWR environments, and other mitigation measures such as using more resistant materials or protective coatings may be included in the program.

(c) The preventive actions program element does not provide guidance to monitor the periods of operation without HWC, and to periodically update crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.

(d) The parameters monitored/inspected program element to clarify that inspection relief under 10 CFR 50.55a(a)(3) in accordance with the guidelines of BWRVIP-62 is approved on a case-by-case basis.

(e) The detection of aging effects program element does not include the recent guidance for stub tube weld repair activities.

(f) The OpE should include the information regarding IGSCC cracks in the HAZ of the stub tubes adjacent to the stub-tube-to-housing weld and not in the Alloy 182 weld.

4.2.8.4 Recommendations for Subsequent License Renewal

4.2.8.4.1 Good Practices or Strengths of AMP XI.M8

M8.1S-1: *Recommendation*: The corrective actions, root cause analyses performed by the applicant to resolve the stub tube cracking, and preemptive actions to develop alternative weld repair techniques are considered good practices or strengths of the AMP.

***Technical Basis*:** At NMP-1, as of 2008, 33 out of the 129 CRD penetration stub tubes have been repaired by roll expansion to a nominal 4% wall thinning. Out of these, only one penetration (50-19) has been re-roll expanded to 6% wall thinning due to repeated occurrence of leakage. No leaks related to stub tube degradation have been observed since NMP-1 entered the PEO. The licensee currently relies on the roll-expansion repair method in accordance with ASME Code Case N-730. However, in the event roll-expansion repair does not prevent leakage, the licensee is working preemptively to get NRC approval for a weld repair method based on ASME Code Case N-606-1 and BWRVIP-58.

4.2.8.4.2 Areas of AMP XI.M8 for Further Consideration/Enhancement

Program Description:

M8.0-1: *Recommendation*: Revise the program description to include the objective of the program.
***Technical Basis*:** Although the objective of the AMP is described in the scope of program, the program description should also include the program objective and state clearly that this program is focused on managing the effects of cracking due to cyclic loading and SCC, including IGSCC, in BWR attachments. This is the most important component of the program description and should be clearly included in this section.

M8.0-2: *Recommendation*: Revise the program description to include guidance for applicants to address all AAIs related to BWRVIP reports referenced in the AMP.
***Technical Basis*:** All three of the program basis BWRVIP documents have AAIs associated with their NRC SERs. The applicants are required to address these AAIs in Appendix C of their LRAs. The components and associated BWRVIP documents are as follows: SLC nozzles/core plate ΔP nozzles, BWRVIP-27-A; lower plenum components, BWRVIP-47-A; and instrument penetration, BWRVIP-49-A. The guidance of these BWRVIP documents has to be implemented by all BWR licensees. Site procedures require a technical justification to be documented and the NRC to be notified for any deviation from the guidelines. Therefore, to ensure compliance, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP reports referenced in the AMP.

M8.0-3: *Recommendation*: Revise the program description (and detection of aging effects program element) to include some clarification for licensees who implemented the GALL, Rev. 0, AMP.
***Technical Basis*:** Consistent with the GALL, Rev. 0, AMP XI.M8, the NMP-1 program basis document does not reference the BWRVIP-47-A document, which addresses the BWR lower plenum inspection and evaluation. However, at NMP-1, the inspection and evaluation guidelines in BWRVIP-47-A have been implemented as part of the BWR vessel internals program. Therefore, for licensees who may have implemented the GALL, Rev. 0, AMP, it may be helpful to include some clarification that for LTO license renewal; all applicants must implement the GALL, Rev. 2, AMP or an updated version of that program.

1. Scope of Program:

M8.1-1: *Recommendation*: Revise the scope of program to include the material of the BWR penetrations and associated welds.
***Technical Basis*:** The scope of this program is applicable to BWR instrumentation penetrations, CRD housing and ICMH penetrations, and BWR SLC nozzles/Core ΔP nozzles. However, the scope of program does not identify that the material of these components is SS or nickel alloy.

This information should be included in the scope of program, and is very important regarding the mitigation actions described next in preventive actions. For example, decreasing the corrosion potential does not necessarily decrease the susceptibility to SCC of all Ni alloys. Furthermore, for Ni alloys, fatigue crack initiation is significantly faster in low-potential than in high-potential reactor coolant environments.

2. <u>Preventive Action</u>:

M8.2-1: *Recommendation*: Revise the preventive actions program element to include some clarification regarding SCC susceptibility of Ni alloys in HWC and NWC BWR environments, and other mitigation measures such as using more resistant materials or protective coatings that may be included in the program.
***Technical Basis*:** This program element states, "maintaining high water purity reduces susceptibility to SCC or IGSCC." In addition, the licensee stated that OpE supports the effectiveness of HWC/NMCA on the mitigation of IGSCC in sensitized SS and Alloy 182. However, these statements are not entirely correct. Decreasing the corrosion potential does not necessarily decrease the susceptibility of all Ni alloys to SCC. Furthermore, for Ni alloys, fatigue crack initiation is significantly faster in low-potential than in high-potential reactor coolant environments. This program element should be revised to include a clarification regarding the differences in the SCC susceptibility and fatigue crack initiation behavior of Ni alloys in HWC and NWC BWR environments. In addition, some other mitigation measures such as using more resistant materials and weld metal (e.g., Alloy 82 instead of Alloy 182) or protective coatings may be included in the program.

M8.2-2: *Recommendation*: Revise the preventive actions program element to include some guidance to monitor the periods of operation without HWC, and periodically update crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.
***Technical Basis*:** The NMP-1 plant is currently operating under HWC/NMCA to mitigate IGSCC. However, although the water chemistry guidelines in EPRI TR-103515 recommend that hydrogen injection, sampling frequencies, and action levels for feedwater iron and copper commence at 10% power, NMP-1 plant takes an exception to this guideline and does not commence these sampling activities until 30% power. The operating time between 10% and 30% power is considered relatively short and insignificant. The unavailability of HWC may allow pre-existing in-vessel cracks to grow or new cracks to initiate. For SLR, it would be advisable to monitor the periods of operation without HWC, and periodically update any crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.

3. <u>Parameters Monitored/Inspected</u>:

M8.3-1: *Recommendation*: Revise the parameters monitored/inspected program element to clarify that inspection relief under 10 CFR 50.55a(a)(3) in accordance with the guidelines of BWRVIP-62 is approved on a case-by-case basis.
***Technical Basis*:** The GALL, Rev. 0, AMP includes the following relief: An applicant may use the guidelines of BWRVIP-62 for inspection relief for vessel internal components with HWC. However, the applicant stated that the BWRVIP-62 guidelines are not being applied to NMP-1 and NMP-2. Although both units use HWC, it is conservatively not credited for inspection relief at either unit. The guidelines of BWRVIP-62 for inspection relief have been deleted from GALL, Rev 2. Relief is on a case-by-case basis. Licensees can request relief under 10 CFR 50.55a(a)(3) for use of HWC, and such a relief is approved only for a 10-year interval. Since <u>inspection relief under 10 CFR 50.55a(a)(3) in accordance with the guidelines of BWRVIP-62 is approved on a case-by-case basis, and only for 10 years</u>, it would be prudent to add the above

underlined information in this program element for those licensees who may have earlier requested inspection relief when operating under HWC.

4. <u>Detection of Aging Effects</u>:

M8.4-1: *Recommendation*: Revise the detection of aging effects program element to include the recent guidance for stub tube weld repair activities.
***Technical Basis*:** The licensee currently relies on the roll-expansion repair method in accordance with ASME Code Case N-730, and is seeking NRC approval for deviations from the requirements of ASME Code Case N-606-1 for CRD stub tubes weld repair. However, in the event roll-expansion repair does not prevent leakage, the licensee is also working to get NRC approval for a weld repair method of Code Case N-606-1 and BWRVIP-58. Code Case N-606-1 provides the requirements for performing a DMW repair without preheat and post soak heat treatments on the reactor vessel and CRD housing interface. For SLR, the detection of aging effects program element may be revised to include the recent guidance for stub tube weld repair activities.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M8.10-1: *Recommendation*: Update the OpE to include the information regarding IGSCC cracks in the HAZ of the stub tubes adjacent to the stub-tube-to-housing weld, and not in the Alloy 182 weld.
***Technical Basis*:** At NMP-1, as of 2008, 33 out of the 129 CRD penetration stub tubes have been repaired by roll expansion to a nominal 4% wall thinning. Out of these, only one penetration (50-19) has been re-roll expanded to 6% wall thinning due to repeated occurrence of leakage. The licensee stated that the stub tubes were furnace sensitized and, therefore, were susceptible to IGSCC, and that the shorter stub tubes located around the perimeter of the bottom head were more susceptible to IGSCC than the longer stub tubes in the center. No leaks related to stub tube degradation have been observed since NMP-1 entered the PEO. The licensee also stated that the IGSCC cracks were observed in the HAZ of the stub tubes adjacent to the stub-tube-to-housing weld. This is an interesting observation; IGSCC was

observed in the stub tube HAZ adjacent to the housing weld and not the dissimilar-metal weld (Alloy 182) between the vessel and the stub tube. This information may be significant and should be included in this program element.

4.2.9 BWR Vessel Internals (XI.M9)

4.2.9.1 Objective and Scope of AMP XI.M9

The objective of this AMP is to manage the effects of cracking due to SCC, IGSCC, IASCC, or cyclic loading (including flow-induced vibrations), loss of material due to wear, and loss of fracture toughness due to thermal and/or neutron embrittlement, on the long-term integrity and safe operation of BWR vessel internal components. The program does not directly monitor for loss of fracture toughness induced by thermal aging or neutron irradiation embrittlement. The impact of loss of fracture toughness on component integrity is indirectly managed using visual or volumetric examination techniques to monitor for cracking in the components.

The program applies to wrought and cast reactor vessel internal components, which include core shroud, core plate, core spray, shroud support, jet pump assembly, low-pressure coolant injection (LPCI) coupling, top guide, CRD housing, lower plenum components, and steam dryer. The materials include wrought and CASS, nickel alloys (e.g., Alloy 600, X-750), precipitation-hardened martensitic steels (e.g., 15-5 and 17-4 precipitation-hardened steel), and martensitic SSs (e.g., 403, 410, and 431 steel).

To ensure that potential detrimental effects of cracking would be adequately managed such that the intended functions of the BWR vessel internals are maintained during the PEO, the AMP relies on the following AMAs:

(1) ISI to monitor the effects of cracking on the intended function of the components, and guidelines of applicable and Staff-approved BWRVIP reports as the basis for inspection, evaluation, repair and/or replacement, as needed. The BWRVIP guidelines provide information on component description and function; evaluate susceptible locations and safety consequences of failure; provide recommendations for methods, extent, and frequency of inspection; discuss acceptable methods for evaluating the structural integrity significance of flaws detected during these examinations; and recommend repair and replacement procedures.

(2) Mitigation measures to reduce the corrosion potential or susceptibility for SCC or IGSCC by monitoring and control of reactor water chemistry based on the most recent NRC-approved industry guidelines. Currently, these guidelines for BWRs are contained in BWRVIP-190.

(3) Determination of the susceptibility of CASS components to thermal aging embrittlement based on casting method, molybdenum (Mo) content, and percent ferrite, and for “potentially susceptible” components, aging management, is accomplished through (a) qualified visual inspections, such as enhanced visual examination (EVT-1); (b) a qualified UT methodology; or (c) a component-specific flaw tolerance evaluation in accordance with the ASME Code, Section XI. However, the guidance provided in this program is not applicable to CASS materials with 25% ferrite or that contain >0.2% niobium, particularly when the licensee uses option (c) for potentially susceptible CASS components and performs a flaw tolerance evaluation to demonstrate adequate toughness. Such CASS materials require evaluation on a case-by case basis.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1;
(ii) BWRVIP-76-A (EPRI 1019057), *BWR Vessel and Internals Project, BWR Core Shroud Inspection and Flaw Evaluation Guidelines*;

(iii) BWRVIP-25 (EPRI 107284), *BWR Vessel and Internals Project, BWR Core Plate Inspection and Flaw Evaluation Guidelines*;
(iv) BWRVIP-18-A (EPRI 1011469), *BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines*;
(v) BWRVIP-38 (EPRI 108823), *BWR Vessel and Internals Project, BWR Shroud Support Inspection and Flaw Evaluation Guidelines*;
(vi) BWRVIP-41 (EPRI 108728), *BWR Vessel and Internals Project, BWR Jet Pump Assembly Inspection and Flaw Evaluation Guidelines*;
(vii) BWRVIP-42-A (EPRI 1011470), *BWR Vessel and Internals Project, BWR LPCI Coupling Inspection and Flaw Evaluation Guidelines*;
(viii) BWRVIP-26-A (EPRI 1009946), *BWR Vessel and Internals Project, BWR Top Guide Inspection and Flaw Evaluation Guidelines, and* BWRVIP-183 (EPRI 1013401), *BWR Vessel and Internals Project, Top Guide Beam Inspection and Flaw Evaluation Guidelines*;
(ix) BWRVIP-47-A (EPRI 1009947), *BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines*;
(x) BWRVIP-139 (EPRI 1011463), *BWR Vessel and Internals Project, Steam Dryer Inspection and Flaw Evaluation Guidelines*;
(xi) BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines-2008 Revision*;
(xii) The guidance in letter dated May 19, 2000, from Christopher Grimes, NRC, to Douglas Walters, NEI, and research data presented in NUREG/CR-4513, Rev. 1, *Estimation of Fracture Toughness of Cast Stainless Steels during Thermal Aging in LWR Systems*;
(xiii) The description of EVT-1 found in BWRVIP-03, Rev. 6; and
(xiv) ASME Section XI, Subsections IWA-3000 for flaw evaluation and IWA-4000 for corrective action; and the guidance of several other BWRVIP reports for repair design criteria and BWRVIP-14-A, BWRVIP-59-A, BWRVIP-60-A, BWRVIP-61, BWRVIP-62, BWRVIP-99-A, and BWRVIP-100-A reports for performing flaw tolerance and growth analyses.

4.2.9.2 Observations from NMP-1

This AMP is not applicable to Ginna because it is a PWR. The NMP-1 BWR Vessel Internals Program B2.1.8 is an existing program that is consistent with the recommendations of AMP XI.M9 of the GALL Report, Rev. 0. In the LRA NMP-1 committed to enhance the BWR Vessel Internals Program, detailed in the AEA TLR, ML13122A009.

Since the audit, NMP-1 has approved and budgeted the contingency for a CRD stub tube leak weld repair, if needed, during the 2013 RFO. The site-specific OpE at NMP-1 includes core shroud cracking, shroud support weld cracking, CRD stub tube cracking due to IGSCC and leakage, and top guide cracking. Although some events occurred prior to the 2004 LRA and the 2009 PEO entry, they provide general background. Detailed information is available in the AEA TLR, ML13122A009.

The deficiencies identified by the BWRVIP program activities have been repaired, replaced, or evaluated per BWRVIP program guidelines and station implementing procedures. The following adverse trends and NMP-1 responses were identified in the program health report:

- Newly identified cracking on the dryer support brackets required monitoring and contingency repair planning.
- Implementation HWC in service at low power is scheduled for 2013 outage to mitigate growth of pre-existing in-vessel cracks.

The long term significance of continued growth of cracks in core shroud vertical welds V9 and V10 indicates effective crack flanking by noble metal chemical addition (NMCA) at NMP-1 (where crack flanking is the result of crack extension that can occur in NMCA plants during periods with hydrogen off or even during more extended periods with hydrogen on (BWRVIP-219, EPRI TR-1019071)).

4.2.9.3 Effectiveness of AMP XI.M9 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to NMP-1 was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.9, "AMP Worksheet XI.M9 BWR Vessel Internals." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.9.4.

4.2.9.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description of GALL, Rev. 2, AMP XI.M9 does not include which aging effects caused by what aging degradation mechanism are being managed by the AMP.

(b) The program description does not include a statement that the synergistic effects of thermal and neutron embrittlement should be addressed in the program.

(c) To ensure compliance with the requirements of various basis or supporting BWRVIP documents, the program description (or scope of program) should clarify that the licensee should address all AAIs associated with these BWRVIP reports.

The AMPs implemented by NMP-1, and by most of the BWR license renewal applicants in general, have been consistent with GALL AMP XI.M9. Therefore, there have been no industry-proposed exceptions or enhancements to this AMP.

No good practices or strengths of the AMP were identified in this review. In addition, information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.9.3.2 Effectiveness and Implementation of AMP XI.M9

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The preventive action program element does not include guidance for licensees to monitor the periods of operation without HWC (or HWC/NMCA), and to periodically update any crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.

(b) The preventive action program element does not include any supporting documentation or analyses that validate the statement, "the program maintains operating tensile stresses below a threshold limit that precludes IGSCC of X-750 material."

(c) The parameters monitored/inspection program element does not include an assessment of the degradation processes based on the total neutron dose for each component.

(d) The acceptance criteria do not include validation of the 10-year inspection interval for reactor vessel internal components, including the effects of plant modifications such as EPU. In addition, the BWRVIP-100-A report, which provides guidance for estimating the decrease in fracture toughness of SS components due to neutron embrittlement, is not referenced in this AMP.

(e) The scope of program does not include an assessment of the design basis analyses of the core shroud clamps that may be installed as part of core shroud repair. In addition, the NMP-1 OpE of core shroud horizontal weld and vertical weld cracking should be included in this AMP.

4.2.9.4 Recommendations for Subsequent License Renewal

4.2.9.4.1 Good Practices or Strengths of AMP XI.M9

No specific good practice was identified during the review.

4.2.9.4.2 Areas of AMP XI.M9 for Further Consideration/Enhancement

Program Description:

M9.0-1: *Recommendation*: Revise the program description to include the objective of the program.
***Technical Basis*:** The program description for XI.M9 AMP in Rev. 2 of the GALL Report does not include the objective of the program; it does not state which aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the most important component of the program description and should be clearly described in this section. It should state that this AMP manages the following aging effects/aging mechanisms: cracking due to SCC, IGSCC, or IASCC, loss of fracture toughness due to thermal embrittlement and/or neutron embrittlement, loss of material due to wear (jet pump wedge surface), and cracking due to flow induced vibrations (steam dryer).

M9.0-2: *Recommendation*: Revise the program description to include a statement that the synergistic effects of thermal and neutron embrittlement should be addressed in the program.
***Technical Basis*:** The program to manage loss of fracture toughness of CASS reactor internal components due to thermal aging embrittlement and neutron embrittlement is essentially AMP XI.M13 of GALL Report, Rev. 1, and is acceptable. However, the program description of this AMP XI.M9 does not include an important component of the GALL, Rev. 1, AMP XI.M13 that the synergistic effects of thermal and neutron embrittlement should be addressed in the program.

M9.0-3: *Recommendation*: Revise the program description to clarify that all AAIs related to BWRVIP reports referenced in the AMP need to be addressed.
***Technical Basis*:** Seven of the ten BWRVIP documents that are referenced in this AMP and provide inspection and evaluation guidance have AAIs associated with their NRC SERs. The applicants are required to address these AAIs in Appendix C of their LRAs. The components and associated BWRVIP documents are as follows: core plate, BWRVIP-25; core spray, BWRVIP-18-A; shroud support, BWRVIP-38; jet pump assembly, BWERVIP-41; LPCI coupling, BWRVIP-42-A; top guide, BWRVIP-26-A and BWRVIP-183; and lower plenum components, BWRVIP-47-A. Site procedures require a technical justification to be documented, and the NRC to be notified, for any deviation from the guidelines. To ensure compliance, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP reports referenced in the AMP.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

M9.2-1: *Recommendation*: Revise the preventive action program element to include guidance for licensees to monitor the periods of operation without HWC (or HWC/NMCA), and to periodically update any crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.
***Technical Basis*:** The water chemistry guidelines in EPRI TR-103515-R0 recommend that hydrogen injection and sampling frequencies and action levels for feedwater iron and copper commence at 10% power. However, NMP-1 takes an exception to this guideline and the sampling activities do not commence until 30% power. Their justification is that that the filter samples collected below 30% power are not representative and the operating time between 10% and 30% power is relatively short and considered insignificant. The unavailability of HWC may allow preexisting in-vessel cracks to grow or new cracks to initiate. Therefore, for LTO, it would be advisable to monitor the periods of operation without HWC, and periodically, or when deemed necessary, update any crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.

M9.2-2: *Recommendation*: Revise the preventive action program element to include supporting documentation or analyses that validate the statement “the program maintains operating tensile stresses below a threshold limit that precludes IGSCC of X-750 material.”
***Technical Basis*:** The preventive actions program element of the GALL AMP states, “for core shroud repairs or other IGSCC repairs, the program maintains operating tensile stresses below a threshold limit that precludes IGSCC of X-750 material.” However, the GALL AMP does not provide any details regarding this threshold stress (i.e., the basis for defining this threshold stress and the associated material and environment conditions). Such information must be included in this program element, particularly when the OpE program element states, “IGSCC in

the X-750 materials of a tie rod coupling and jet pump hold-down beam was observed in a domestic plant." The statement regarding the tensile stresses in X-750 components in the preventive action program element needs to be qualified.

3. <u>Parameters Monitored/Inspected</u>:

M9.3-1: *Recommendation*: Revise the parameters monitored/inspection program element to include an assessment of degradation processes based on the total neutron dose for each component.
***Technical Basis*:** The program primarily monitors the effect of cracking on the intended function of the reactor internal components by detecting and sizing cracks by inspection. However, with continued operation the total accumulated neutron dose also continues to increase. For example, at NMP-1, the best estimate neutron fluence for the top guide was 4.4 x 10^{21} n/cm^2 (6.6 displacements per atom [dpa]) at the time of the top guide UT examination performed in 2005. Therefore, the total neutron dose is likely to exceed the threshold levels for susceptibility to IASCC, neutron embrittlement, or stress relaxation for several reactor internal components. It would be prudent to monitor the total dose of select set of components to identify the potential for IASCC susceptibility or neutron embrittlement or stress relaxation of bolted components so that the management activities needed to manage these aging degradations can be adequately defined.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M9.6-1: *Recommendation*: Revise the acceptance criteria to include validation of the 10-year inspection interval for highly irradiated components and includes the effects of plant modifications such as EPU. In addition, add BWRVIP-100-A to the references section of this AMP.
***Technical Basis*:** The acceptance criteria are in accordance to applicable BWRVIP reports or ASME Code Section XI. However, the BWRVIP-100-A report, which provides guidance for estimating the loss of fracture toughness due to neutron embrittlement, is not referenced in this AMP. In addition, this AMP follows the ASME Section XI 10-year inspection interval for all reactor vessel internal components. Recent data indicate that exposure to neutron irradiation to 5–8 dpa decreases the fracture toughness J_{Ic} value of SSs from well above 200 kJ/m^2 to as low as 7.5 kJ/m^2 (or K_{Jc} of 38 MPa m$^{1/2}$) (NUREG/CR-7027, Dec. 2010). In view of significant reduction in fracture toughness and very high crack growth rates (both fatigue and SCC growth rates), the applicant should validate the 10-year inspection interval. Furthermore, the potential effect of plant modifications such as EPU on flaw tolerance analyses should also be evaluated.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M9.10-1: *Recommendation*: Update the OpE program element of this AMP to include the inspection results at NMP-1, and revise the scope of program to include an assessment of the design basis analyses of the core shroud clamps.
***Technical Basis*:** In 1995, following the BWRVIP-01 baseline inspection NMP-1 plant identified core shroud horizontal weld cracking. The corrective action taken was to install a preemptive core shroud tie-rod repair in accordance with BWRVIP-02 shroud repair guidelines. In addition, core shroud vertical weld cracking was identified in 1997 and preemptive vertical weld clamps were installed in 1999. Recent inspections have shown that although no new vertical weld cracking has occurred, the V9 and V10 weld cracks have continued to grow in depth and are effectively through-wall. The licensee stated that the design assumptions used in the analyses bound the condition of the vertical weld clamps on V9 and V10. However, it is not clear whether the design basis analyses for the vertical weld clamps were updated during license renewal to ensure that they were consistent with the requirements of current Codes and standards, and whether the effects of plant modifications on these analyses were addressed. In addition, if these clamps are made of X-750, industry OpE indicates that IGSCC has been observed in X-750 materials.

4.2.10 Boric Acid Corrosion (XI.M10)

4.2.10.1 Objective and Scope of AMP XI.M10

The objective of the Boric Acid Corrosion program is to manage the aging effects of loss of material due to boric acid corrosion on the intended function of an affected structure or component. The program relies, in part, on the implementation of recommendations in GL 88-05 to monitor the condition of the reactor coolant pressure boundary for borated water leakage to ensure that corrosion caused by leaking borated coolant does not lead to degradation of the leakage source or adjacent structures and components, and provides assurance that the reactor coolant pressure boundary will have an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. In addition to online monitoring of pressure boundary leakage, as per NRC's RG 1.45, periodic visual inspection of adjacent structures, components, and supports for evidence of leakage and corrosion is an element of the GL 88-05 monitoring program. The GL 88-05 program for procedurally controlling wastage due to boric acid corrosion consists of the following activities:

1. A determination of the principal locations where leaks that are smaller than the allowable technical specification limit can cause degradation of the primary pressure boundary by boric acid corrosion. Particular consideration should be given to identifying those locations where conditions exist that could cause high concentrations of boric acid on pressure boundary surfaces.

2. Procedures for locating small coolant leaks (i.e., leakage rates at less than technical specification limits). It is important to establish the potential path of the leaking coolant and the reactor pressure boundary components it is likely to contact. This information is important in determining the interaction between the leaking coolant and reactor coolant pressure boundary materials.

3. Methods for conducting examinations and performing engineering evaluations to establish the impact on the reactor coolant pressure boundary when leakage is located. This should include procedures to promptly gather the necessary information for an engineering evaluation before the removal of evidence of leakage, such as boric acid crystal buildup.

4. Corrective actions to prevent recurrences of this type of corrosion. This should include any modifications to be introduced in the present design or operating procedures of the plant that (a) reduce the probability of primary coolant leaks at the locations where they may cause corrosion damage and (b) entail the use of suitable corrosion resistant materials or the application of protective coatings/claddings.

Potential improvements to boric acid corrosion programs have been identified because of OpE with cracking of certain nickel alloy pressure boundary components (NRC Regulatory Issue Summary 2003-013). One resulting action was the issuance of NRC Order EA-03-009 issued in 2003 (revised in 2004) requiring licensees for operating PWRs to conduct periodic bare metal visual inspections of 100% of the reactor pressure vessel head surface, as well as ultrasonic or eddy current inspections of the head penetration nozzle and J-groove weld regions. The inspection frequencies range from every refueling outage to every fifth refueling outage or every seven years, depending upon the plant's calculated susceptibility to PWSCC. The detailed inspection requirements are described in ASME Code Case N-729-1, subject to certain NRC-imposed limitations and conditions.

Therefore, adherence to GL 88-05 alone does not result in an effective boric acid control AMP due to the following limitations with GL 88-05:

1. The AMP program should identify the locations that are susceptible to cracking, including Ni-alloy components and welds.

2. Guidance on reactor coolant system (RCS) leak detection is provided in NRC RG 1.45 ("Guidance on Monitoring and Responding to Reactor Coolant System Leakage") issued in May 2008. Even though RG 1.45 states that it is applicable only to new reactors in accordance with the requirements of 10 CFR 50.34(h), it provides useful information on leakage detection and monitoring that can be used in existing plants. Despite such guidance, however, detection of leakage during power operation continues to be problematic.

3. The exact location or the magnitude of leaks may not be ascertained by merely searching for the presence of boric acid crystals on leaking components or nearby targets because boric acid crystals could become airborne and be deposited on other locations such as containment ventilation filters.

4. Leakage of borated water from piping and components that are outside the scope of the program established in response to GL 88-05 may affect structures and components that are subject to AMR. Therefore, the scope of monitoring and inspections of this program includes all components which contain or transport borated water or in close proximity to structures and components that contain/transport borated water are subject to AMR. The scope of the evaluations, assessments, and corrective actions include all observed leakage sources and the affected structures and components.

5. Borated water leakage may be discovered through activities other than those established specifically to detect such leakage. Therefore, the program includes provisions for triggering evaluations and assessments when leakage is discovered by other activities. The effects of boric acid corrosion on reactor coolant pressure boundary materials in the vicinity of nickel alloy components are managed by GALL AMP XI.M11B, "Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-induced Corrosion in Reactor Coolant Pressure Boundary Components."

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) NRC Generic Letter 88-05, *Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants*, NRC, March 17, 1988; and
(ii) NRC Regulatory Issue Summary 2003-013, *NRC Review of Responses to Bulletin 2002-01, 'Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity,'* NRC, July 29, 2003.

4.2.10.2 Observations from Ginna and NMP-1

This AMP is not applicable to NMP-1, since it is a BWR. Ginna implements this program through a plant-specific administrative procedure developed to meet the recommendations of Generic Letter (GL) 88-05. This procedure became the Boric Acid Corrosion program (AMP B2.1.16 in the Ginna LRA) and was made consistent with AMP XI.M10 of the GALL Report, Rev. 0, by enhancing it to account for boric acid corrosion of non-reactor coolant system (RCS) components located in areas where there is the potential for boric acid leakage, including cable connections, cable trays, and other susceptible SSCs.

Consistent with the guidance of NRC Regulatory Issue Summary (RIS) 2003-013, the Ginna AMP includes the identification of reactor coolant system locations that contain nickel alloys or welds (e.g., control rod penetrations) for inspection. At Ginna, an initial inspection by a team of pipe fitting and decontamination staff examines relevant surfaces when the system is "as hot as possible," to identify locations of interest. A second team, composed of a VT-2 qualified inspector (with boric acid training per EPRI 1022326) and a trainee or support engineer, later implements follow-up activities later. Ginna personnel stated that they specifically look for rust-colored stains in their visual examinations of boric acid deposits. They also stated that when leakage is identified within the containment or in an area with enclosed ventilation units, the ventilation units are examined for evidence of boric acid deposits. This activity of examining the ventilation units for evidence of boric acid wastage residue is of particular importance in view of the operating experience at the Davis-Besse plant.

The program looks at two characteristics for findings: (1) whether the leak is still active and (2) the volume, color, and location of deposits. The plant personnel stated that they do not restart with active leaks, consistent with the technical specification (TS), and they try to leave no deposits. Their program incorporates a fluid leakage management program for borated systems that looks at leakage severity and considers the risk of locations that have been exposed to leakage. Locations with high and medium risk are generally repaired immediately, whereas low-risk locations may be combined into a single CR for later remediation. Their implementing procedures include provisions for replacement with insusceptible materials. The staff noted that Ginna continues to find and correct boric acid leakage, with a fairly constant number of CRs identified at each refueling outage.

4.2.10.3 Effectiveness of AMP XI.M10 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to Ginna were reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy; and, (b) evaluating the results of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent implementation. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.10, "AMP Worksheet XI.M10 Boric Acid Corrosion." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. Recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.10.4.

4.2.10.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

(a) The program description of GALL Rev. 2, AMP XI.M10 does not include a statement of the following objective of the program: the AMP manages the aging effects of loss of material due to boric acid corrosion on the intended function of an affected structure or component.

(b) The management of boric acid corrosion (or wastage) caused by coolant leakage from cracks in nickel-alloy components is treated separately and covered within GALL AMP XI.M11B for "Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-induced Corrosion in Reactor Coolant Pressure Boundary Components."

(c) The program description of the GALL AMP refers to the recommendations in GL 88-05 and the guidance in Regulatory Issue Summary (RIS) 2003-013, but it does not address the sufficiency of this guidance. For example, the GALL AMP does not describe the four aging management activities mentioned in GL 88-05 for managing boric acid wastage or identify the various potential weaknesses in the Boric Acid Corrosion program associated with these four aging management activities.

The Boric Acid Corrosion Program implemented by Ginna is stated in the LRA to be consistent with GALL, Rev. 0 AMP XI.M10 with the enhancement that it also manages boric acid wastage of components outside of the RCS, including cable connectors and cable trays as well as other susceptible SSCs. As stated in the SER, "This AMP is credited with managing the aging of CS and low-alloy steel structures or components or electrical components on which borated water may leak in the RCS, ESF [engineered safety features], SPCS [steam and power conversion systems], structures and component supports, and electrical systems. The applicant's program was developed and implemented to meet GL 88-05 'Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants,' and to monitor the condition of the RCS pressure boundary components for boric acid leakage. The program identifies CS components within the RCS that are susceptible to corrosion from boric acid leakage and provides for visual inspection of adjacent components."

No good practices or strengths of the AMP were identified in this review. In addition, information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.10.3.2 Effectiveness and Implementation of AMP XI.M10

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M10 Program Element 2 ("Preventive Actions"): does not state that modifications in the design and operating procedures to reduce coolant leakage, use of corrosion resistant materials or protective coating, and timely removal of any boric acid deposits from susceptible reactor components are all measures that prevent and manage boric acid wastage.

(b) GALL XI.M10 Program Element 3 ("Parameters Monitored/Inspected"): in view of the OpE at Davis Besse, this program element should include a statement that when a leakage is identified within the containment or in an area with enclosed ventilation units, the ventilation units are evaluated for evidence of boric acid deposits to ensure that it does not contain rust-like stains. Also, consider possible evaluation of filters upon change-out for evidence of rust-like stains that could be evidence of leaking.

(c) GALL XI.M10 Program Element 4 ("Detection of Aging Effects"): the presence of rust-colored stains in the boric acid surface residue is an indicator of possible significant corrosion of the underlying ferritic material.

(d) GALL XI.M10 Program Element 7 ("Corrective Actions"): although the Boric Acid Corrosion program continues to find coolant leakage and boric acid deposits, the rate of these discoveries appears to be relatively constant.

(e) GALL XI.M10 Program Element 10 ("Operating Experience"): although this program element references a few NRC generic communications in which plant experience related to boric acid corrosion is described, it does not provide an assessment of the relative severity and safety significance of these events.

4.2.10.4 Recommendations for Subsequent License Renewal

4.2.10.4.1 Good Practices or Strengths of AMP XI.M10

No specific items identified.

4.2.10.4.2 Areas of AMP XI.M10 for Further Consideration/Enhancement

Program Description:

M10.0-1: *Recommendation*: Consider adding an opening sentence to the program description to clearly state that the objective of this program is to detect borated water leakage in order to prevent or mitigate boric acid corrosion and contribution to degradation of susceptible SSCs.

***Technical Basis*:** The program description for XI.M10 AMP in Rev. 2 of the GALL Report begins by referencing the recommendations of GL 88-05 concerning the monitoring of the condition of the reactor coolant pressure boundary for borated water leakage. Although it may seem obvious that the ultimate purpose of this detection activity is to prevent or mitigate boric acid corrosion of susceptible SSCs, it is preferable to state this explicitly in the first sentence.

M10.0-2: *Recommendation*: Instead of duplicating the GALL AMP XI.M10 guidance in GALL AMP XI.M11B, it may be advantageous to manage boric acid wastage within GALL AMP XI.M10 and the GALL AMP XI.M11B was simply used for managing the aging effects of cracking of nickel alloy components and welds in the RCPB components.

***Technical Basis*:** It is not clear why the management of loss of material due to boric acid corrosion (or wastage) caused by coolant leakage from cracks in nickel-alloy components is treated separately and not covered under GALL AMP XI.M10, "Boric Acid Corrosion," which specifically deals with this issue. Furthermore, the GALL AMP XI.M11B for nickel-alloy cracking due to PWSCC does not include any guidance regarding engineering evaluations and corrective actions that need to be performed once leakage is discovered, to ensure that boric acid wastage does not lead to further degradation of the leakage source or adjacent structures or components.

M10.0-3: *Recommendation*: It would be advantageous for consistency in implementation if the specific guidance in GL 88-05 and RIS 2003-013 documents were clearly identified in the program description.

***Technical Basis*:** Although program description of the GALL AMP refers to the recommendations in GL 88-05 and the guidance in RIS 2003-013, it does not provide any details regarding the various activities of the program. For example, the GL 88-05 program for procedurally controlling wastage due to boric acid corrosion consists of four aging management

activities, and RIS 2003-013 describes the weaknesses that have been identified by the NRC staff in implementation of these four activities in GL 88-05.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

M10.2-1: *Recommendation*: Revise this program element to clarify that modifications in the design and operating procedures to reduce the probability of coolant leakage, the use of corrosion resistant materials or protective coating, and timely removal of any boric acid deposits from susceptible reactor components are all measures that prevent and manage boric acid wastage.

***Technical Basis*:** The aging management activities recommended in GL 88-05 include preventive measures such as "modifications in the design and operating procedures, which: (a) reduce the probability of coolant leakage at locations where they may cause corrosion damage and/or promote stress corrosion cracking; and, (b) involve the use of corrosion resistant materials or the application of coatings." Furthermore, the introduction of moisture to boric acid deposits on top of reactor component surfaces from leaking flange connections or cracks in reactor pressure boundary components could lead to significant boric acid wastage. Therefore, timely removal of boric acid deposits and clean-up is a preventive measure and its importance should be included in this program element.

3. <u>Parameters Monitored/Inspected</u>:

M10.3-1: *Recommendation*: Include a statement that when leakage is identified within the containment or in an area with enclosed ventilation units, the ventilation units are examined for evidence of boric acid deposits to ensure that it does not contain rust-like stains.

***Technical Basis*:** At Ginna, when leakage is identified within the containment or in an area with enclosed ventilation units, the ventilation units are evaluated for evidence of boric acid deposits. This activity of examining and evaluating the ventilation units for evidence of boric acid wastage residue is of particular importance in view of the OpE at Davis Besse, and should be included in this program element.

4. <u>Detection of Aging Effects</u>:

M10.4-1: *Recommendation*: Include a statement that any identified boric acid residue will be evaluated for the presence of rust-colored stains.

***Technical Basis*:** The presence of rust-colored stains in the boric acid surface residue is an indication of potentially significant corrosion of the underlying ferritic material. This observation becomes especially important because of the severe boric acid corrosion experienced in the reactor vessel head at the Davis-Besse plant. During the Ginna audit, plant personnel indicated that they specifically look for rust-colored stains in their visual examinations of boric acid

deposits. It is noted that GALL XI.M10 program element 6 ("Acceptance Criteria") does mention the detection of rust-colored stains, but does not explain their possible significance.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

M10.6-1: *Recommendation*: To ensure compliance with the recommendations of GL 88-05, particularly for license renewal for SLR, the next GALL revision may request that applicants prepare a list of primary coolant leakage events that may have caused boric acid wastage, and identify if any of these events were repetitive findings of coolant leaks and/or boric acid deposits at the same location.

***Technical Basis*:** Although the Boric Acid Corrosion program continues to find and correct coolant leakages and boric acid deposits, the rate of these discoveries appears to be fairly constant.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M9.10-1: *Recommendation*: Consider expanding the Operating Experience narrative to briefly describe the various types of boric acid corrosion that have been observed and their significance such as potential reduction in strength due to the reduction in section thickness due to wastage and/or the potential initiation of stress corrosion cracking.

***Technical Basis*:** The present Operating Experience section in GALL, Rev. 2 consists only a single sentence that references NRC generic communications relating to boric acid corrosion plant experience. No information on any assessment of the relative severity and significance of these events is provided. An assessment of the safety significance both from the point of view of potential reduction in strength due to the reduction in section thickness due to wastage and/or the potential initiation of stress corrosion cracking due to boric acid reaction be considered to be important aspects of this AMP.

4.2.11 Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWR only) (XI.M11B)

4.2.11.1 Objective and Scope of AMP XI.M11B

The objective of this program is to manage the aging effects of cracking of nickel alloy components and welds in the RCPB, and any associated boric acid-induced general corrosion (or wastage) of the safety-related components in the vicinity of these nickel alloy components/welds. The boric acid is a required constituent of the PWR primary coolant and its consequential concentration in the vicinity of cracking, if present, in the nickel alloy components/welds, can result in the loss of material of exposed parts made of other susceptible materials such as low-alloy steels or carbon steels. The welds addressed in this AMP include dissimilar metal welds (DMWs joining with the nickel alloy components and the cracking is mostly due to the PWSCC of either the base metal or the weld alloys.

The current inspections required under ASME Code Section XI do not address PWSCC degradation of Alloy 82/182 DMW butt welds in RCPB. These welds, those that are unmitigated, as well as those that have been mitigated for PWSCC by any of the mitigation methods, are addressed in the ASME Code Case N-770-1 (current), which provides the requirements for their inspection frequencies and methods, as amended in 10 CFR 50.55a (current).

The scope and requirements for inspections for PWSCC of RCPB components and welds made of Alloy 600/182/82 materials, which are not addressed under the Code Case N-770-1, are covered by ASME Code Case N-722-1, as amended in 10 CFR 50.55a.

Special (alternative) requirements are applicable to the reactor pressure vessel heads with nozzles fabricated from Alloy 600 that have partial penetration welds of Alloy 182/82 materials, as well as Alloy 690/152/52 materials, to manage their PWSCC for LTO. The scope of these is delineated in the ASME Code Case N-729-1, as amended in 10 CFR 50.55a (current).

Aging effects of any boric acid leakage from non-nickel alloy components are managed in a separate AMP (GALL AMP XI.M10, “Boric Acid Corrosion”). (Note that AMP XI.M11B of GALL Report, Rev. 2, replaced the previous GALL AMPs XI.M11, “Nickel-Alloy Nozzles and Penetrations” and XI.M11A, “Nickel-Alloy Penetration Nozzles Welded to the Upper Reactor Vessel Closure Heads of Pressurized Water Reactors.”)

To ensure that potential aging degradation due to PWSCC and any associated loss of material due to boric acid corrosion of PWR RCPB components in scope of this AMP will be adequately managed such that their intended functional integrity is maintained during the PEO, the AMP relies on three AMAs: (i) performing ISI specifically for the PWSCC of base metal as well as weld material, with qualified examinations, (ii) mitigation efforts to reduce the potential or susceptibility for PWSCC, and (iii) any needed flaw evaluation with corrective action of repair or replacement.

For these AMA activities the AMP relies on the requirements or guidance from the following documents:
(i) ASME Code Cases N-722-1, N-729-1, and N-770-1, as approved and amended under conditions of 10 CFR 50.55a (Final Rule, July 2011);
(ii) ASME Section XI ISI, subject to requirements of the NRC approved Code Cases N-722-1, N-

729-1, and N-770-1, as per 10 CFR 50.55(a); and
(iii) ASME Section XI, Subsections IWB-3500 for flaw disposition, and IWB-3600 for flaw evaluation, and corrective actions, as augmented by the ASME Code Cases 770-N-1 and 729-N-1, subject to the conditions of 10 CFR 50.55a.

4.2.11.2 Observations from Ginna

This AMP is not applicable to NMP-1, since it is a BWR. The Ginna AMP B2.1.26, "Reactor Vessel Head Penetration Inspection," is focused on managing the effects of crack initiation and growth due to PWSCC of the reactor vessel head and bottom-mounted instrumentation (BMI) penetrations of the Ginna reactor vessel. Further details are available in the AEA TLR, ML13122A009.

The Ginna Alloy 600 Program includes the guidance in MRP-139. However, the licensee's PBD indicated that the additional industry positions on Alloy 600 butt welds contained in the EPRI MRP-139 guidelines have limited applicability to Ginna because the Ginna reactor coolant system was constructed using stainless steel butt welds, which are outside the scope of MRP-139 and not subject to PWSCC. The PBD further indicated that the only Alloy 82/182 butt welds in the reactor coolant system are the BMI Alloy 600 nozzle to safe end welds.

As part of the industry-wide initiative relative to GL 97-01, in 1999, Ginna also performed a comprehensive eddy current inspection of all the Alloy 600 vessel closure head penetrations. The results indicated that no cracking had occurred in these nozzles. As a result of these examinations and industry-wide concerns described in NRC Bulletins 2001-01 and 2002-01, Ginna also replaced the reactor vessel head and CRDM penetrations in 2003. The licensee will continue to follow industry developments related to PWSCC of Alloy 600 through participation in various industry initiatives. The licensee's PBD also indicates that during the 2006 refueling outage, an EPU was implemented with a 17% power increase, and the hot leg temperature was increased during this modification to approximately 321°C (610°F). However, because the replacement reactor vessel closure head uses Alloy 690 CRDM nozzles, they are expected to accommodate the increased temperature associated with the EPU conditions.

4.2.11.3 Effectiveness of the AMP XI.M11B to Meet Its Objective

The audit report on the assessment of AMP effectiveness from visit to Ginna was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.11, "AMP Worksheet XI.M11B Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWR only)." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical bases, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.11.4.

4.2.11.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The various documents listed in the description appear to address the same components/locations or overlapping inspection requirements, without actually being clear as to the scope and purpose of each document.

(b) The purpose and interface of this AMP, and the extent of its reliance on GALL AMP XI.M2, "Water Chemistry," are unstated. In addition, it is unclear why the management of (loss of material from) boric acid leakage is different from, and not covered under, GALL AMP XI.M10, "Boric Acid Corrosion," that specifically deals with this issue.

(c) Many of the basis or guideline documents for this AMP (even in GALL Report NUREG-1801, Rev. 2) were either interim or since have been updated for PWSCC management in LTO.

4.2.11.3.2 Effectiveness and Implementation of AMP XI.M11B

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," refers to susceptible nickel-based components (including their welds), without also addressing the scope regarding components fabricated from materials believed to be resistant to PWSCC (e.g., Alloy 690/152/52) and welds (partial or full penetration) that may be mitigated or unmitigated.

(b) Program Element 2, "Preventive Action," needs to emphasize the role of preventive measures and confirmation of their effectiveness, particularly if the program is to manage the PWSCC aging effect over the long term. In addition, use of PWSCC-resistant nickel-based alloys may not provide an absolute guarantee of non-occurrence over the PEO or LTO.

(c) Program Element 3, "Parameters Monitored/Inspected," cites guidance that is either too broad (10 CFR 50.55a) or narrow (e.g., Materials Reliability Program [MRP]-139, which itself may be inapplicable for LTO) without specific considerations related to PWSCC and any associated boric acid leakage (e.g., for on-line monitoring). In addition, although this AMP does refer to the Water Chemistry AMP, identification and monitoring of any off-normal chemistry should be included as part of this program element.

(d) Program Element 5, "Monitoring and Trending," refers to routine plant Technical Specification monitoring and flaw evolution under 10 CFR 50.55a as key activities. It is unclear how these activities interface or improve the management of cracking and leakage, or their monitoring and trending, under this AMP with specific reference to the PWSCC of RCPB components/welds.

(e) Program Element 6, "Acceptance Criteria," needs to be updated with regard to the basis documents and expanded to clarify their scope (applicability), summarizing what and how the criteria do address the PWSCC cracking and boric acid leakage specifically.

(f) Program Element 10, “Operating Experience,” notes that NRC GL 97-01 is effective in managing the effect of PWSCC, and emphasizes the role of the Water Chemistry program (GALL AMP XI.M2) in controlling the chemistry excursions. However, significant instances of PWSCC with generic implications have occurred since 1997 and most of these are under well-controlled water chemistry. This OpE needs to be addressed and summarized in relation to the prior experience and conclusions.

4.2.11.4 Recommendations for Subsequent License Renewal

4.2.11.4.1 Good Practices or Strengths of AMP XI.M11B

M11B.S-1: *Recommendation*: (Based on the audit at Ginna) It is creditable that some licensees have plans to implement the latest revisions of the Code Cases (not in the GALL Report NUREG-1801, Rev. 2) and track the performance of PWSCC-resistant materials of type Alloy 690 and its welds.
***Technical Basis*:** Following the latest industry experience and guidelines to update the AMP with these significant changes is critical to managing the long-term aging effects of PWSCC, partly due to the fact that several basis documents have been evolving and retain interim (short-term) guidance and credits for mitigation efforts are based on conditions which need continued verification.

4.2.11.4.2 Areas of AMP XI.M11B for Further Consideration/Enhancement

<u>Program Description</u>:

M11B.0-1: *Recommendation*: Revise the program description to include updated basis documents, adding clarification on the scope (limitations) and purpose for each document as used in the AMP. For example, the current inspections required under the ASME Code Section XI do not address PWSCC degradation of Alloy 82/182 butt welds; the Code Case N-722 does not address the reactor vessel closure head (even though it may contain Alloy 600/82/182 welds of the Class 1 component), which is covered under Code Case N-729-1, and that N-729-1 scope includes PWSCC-resistant materials as well as PWSCC-susceptible materials. The need for or relevance of industry document MRP-139 for long-term guidance should be clarified as well.
***Technical Basis*:** Several of the key documents cited in the current (Rev. 2) GALL Report AMP were for interim use and have been updated or replaced. The various documents listed in the AMP description appear to address same components/locations or overlapping inspection requirements, without actually being clear as to the scope and purpose of each document. The reason for RIS 2008-25 additional requirements for dissimilar metal butt welds, to supplement N-722, is unclear, while MRP-139, as basis for resolution in RIS 2008-25, is described to be adequate for addressing PWSCC in dissimilar butt welds – but appears to need N-722 as well. Updated Code Cases N-722-1 and N-770-1 may have addressed some guidance issues and inspection requirements for LTO.

M11B.0-2: *Recommendation*: Add clarification for the supplemental role and significance of the AMPs XI.M10 and XI.M2. The boric acid leakage management aspect should be covered under the XI.M10 AMP, or provide the need/clarification for it to be part of this AMP. In addition, if XI.M2 is a requisite supplemental AMP to manage the aging effects of this AMP then this should be clearly stated, along with the reasons.

***Technical Basis*:** It is unclear why the management of (loss of material from) boric acid leakage is different from, and not covered under, the XI.M10 AMP "Boric Acid Corrosion," which specifically deals with this issue. The purpose and interface of this AMP (XI.M11B) and the extent of its reliance on GALL AMP XI.M2, "Water Chemistry," are unstated, especially in the context of even recent OpE that has shown PWSCC under well-controlled water chemistry, while inspection requirements seem to be the main area of coverage under this AMP. At the same time, off-normal chemistry excursions (e.g., sulfate-bearing species or chlorides) are of significant and direct impact on the PWSCC under this AMP, suggesting that their monitoring and control should be part of this AMP.

1. <u>Scope of Program</u>:

M11B.1-1: *Recommendation*: Revise the scope to include areas of PWSCC-resistant materials and RCPB welds, with or without full penetration and with or without mitigation applied.
***Technical Basis*:** The requirements of Code Case N-729-1 for reactor vessel head nozzles and welds include nickel-based alloys believed to be resistant to PWSCC. Other nickel-based components of RCPB, examined and evaluated under N-722-1 and N-770-1, include partial or full penetration, and mitigated or unmitigated welds of PWSCC-susceptible Alloy 600/182/82 under this AMP.

2. <u>Preventive Action</u>:

M11B.2-1: *Recommendation*: Emphasize the role and desired implementation of preventive measures along with confirmation of their effectiveness for LTO, even if not a regulatory requirement at this time.
***Technical Basis*:** Use of PWSCC-resistant nickel-based alloys may not provide an absolute guarantee of non-occurrence over the PEO or LTO. In addition, any mitigation strategy is invariably credited to reduce the inspection requirements under this AMP. These actions and credits need an adequate justification and review with NRC approval, as well as confirmation of their effectiveness, particularly if the program is to manage the PWSCC aging effect over the long term.

3. <u>Parameters Monitored/Inspected</u>:

M11B.3-1: *Recommendation*: Revise the guidance required for online monitoring, specifically for conditions resulting from or leakage due to PWSCC and any associated boric acid effects. In addition, include guidance on identification and monitoring of any off-normal chemistry of significance to PWSCC as part of this program element.
***Technical Basis*:** As noted above, the current AMP guidance is either too broad (10 CFR 50.55a) or too narrow (e.g., MRP-139, which itself may be inapplicable for LTO) without specific considerations related to PWSCC and any associated boric acid leakage (e.g., for online monitoring parameters). In addition, although this AMP does refer to the Water Chemistry AMP, off-normal chemistry parameters (e.g., sulfates and chlorides) have significant impact on the occurrence and assessment of PWSCC throughout the RCPB on a cumulative basis over time.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

M11B.5-1: *Recommendation*: Clarify or revise the guidance provided for the monitoring and trending activities of this AMP with specific reference to PWSCC (and boric acid corrosion) of RCPB.
***Technical Basis*:** The program element refers to routine plant technical specification monitoring and flaw evaluation under 10 CFR 50.55a as key activities. It is unclear how these activities interface or improve the management of cracking and leakage, or its monitoring and trending, under this AMP with specific reference to the PWSCC of RCPB components/welds. It is also unclear what flaw evaluation in 10 CFR 50.55a is being credited, and how, for monitoring purposes. While the plant technical specifications will be the basis for action in response to the results of monitoring and trending activity, it is unclear how this is achieved or addressed. Some justification and guidance in using the results of this program element may be of value to improve the effectiveness of this AMP by identifying precursors.

6. <u>Acceptance Criteria</u>:

M11B.6-1: *Recommendation*: Revise the element description with regard to the basis documents and expand to clarify their scope (applicability), summarizing what and how the criteria do address, specifically the PWSCC cracking and boric acid leakage effects. Relate these to the ASME Code requirements and related Code Cases important to this AMP.
***Technical Basis*:** The current description and guidance is rather limited and vague (or general). Neither the bases nor the objectives (such as flaw size, leakage amount, and final failure mechanism) of intended criteria to be used are stated or clarified. For example, at minimum, indications found during inspections are evaluated per ASME Code Section XI requirements, with applicable amendments per 10 CFR 50.55a. Indications that do not satisfy acceptance criteria of Subsection IWB-3500 are dispositioned by analysis, repaired, or replaced. If a flaw is due to PWSCC then it must be evaluated, regardless of depth, even if it meets the IWB-3500 acceptance standards. The flaw evaluation is performed as per Subsection IWB-3600, or similar technically justified method or approved Code Case methods, subject to the conditions of 10 CFR 50.55a.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M11B.10-1: *Recommendation*: Revise the element with main issues and summary findings, especially since, and in view of, the GL 97-01. Restate the need for, and importance of, OpE-based updating of the AMP implementation.
***Technical Basis*:** The program element notes that GL 97-01 is effective in managing the effects of PWSCC, and emphasizes the role of Water Chemistry program (GALL AMP XI.M2) in

controlling the chemistry excursions. However, significant instances of PWSCC with generic implications have occurred since 1997 and most of these are under well-controlled water chemistry. The OpE of main interest involving hot-leg cracking (at V. C. Summer), closure head CRDM weld cracking leading to boric acid corrosion (at Davis-Besse), and bottom head instrument nozzles (as in the standard test procedure, (STP), does not seem related to any off-normal water chemistry. The aging effect of main interest to this AMP is that of cracking under normally maintained primary water chemistry; it deals with the known and inherent susceptibility, especially over longer terms of operation, of nickel-based alloys to PWSCC, although certain off-normal chemistry excursions need to be carefully assessed. In addition, based on the audit at Ginna, it is worthwhile to note that certain licensees plan to implement the latest revisions of the Code Cases (not in GALL, Rev. 2) and to track the performance of PWSCC-resistant materials of type Alloy 690 and its welds. These licensee actions would ensure that the latest industry experience and evolving guidelines are effectively incorporated into this AMP, which is of significance to the structural and leakage integrity of RCPB; such actions are critical to managing the long-term aging effects of PWSCC.

4.2.12 Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS) (XI.M12)

4.2.12.1 Objective and Scope of Rev. 2 AMP XI.M12

The program manages the effects of loss of fracture toughness due to thermal aging embrittlement of all CASS components, except pump casings and valve bodies. Although the initial aging effect is loss of ductility and fracture toughness, unstable crack extension is the eventual aging effect if a crack is present and the local applied stress intensity exceeds the reduced fracture toughness. To ensure that potential detrimental effects of cracking would be adequately managed such that the intended function of the CASS components is maintained during the PEO, the AMP relies on the following AMAs:

(1) Determination of the susceptibility of CASS components to thermal aging embrittlement based on casting method, molybdenum (Mo) content, and percent ferrite.

(2) For "potentially susceptible" components, aging management is accomplished through either (a) qualified visual inspections, such as enhanced visual examination (EVT-1); (b) a qualified UT methodology; or (c) a component-specific flaw tolerance evaluation in accordance with the ASME Code, Section XI.

However, the guidance provided in this program is not applicable to CASS materials with 25% ferrite or niobium-containing steels, particularly when licensee uses option (c) for potentially susceptible CASS components and performs a flaw tolerance evaluation to demonstrate adequate toughness. Such CASS materials require evaluation on a case-by case basis.

For components that are not susceptible to thermal aging embrittlement, additional inspection or flaw tolerance evaluations to demonstrate that the material has adequate fracture toughness are not required. In addition, screening for susceptibility to thermal aging embrittlement is not required for pump casings and valve bodies. The existing ASME Code Section XI inspection requirements, including the alternative requirements of ASME Code Case N-481 for pump casings, are adequate for all pump casings and valve bodies. Note that Code Case N-481 was annulled on March 28, 2004 because it was incorporated in the ASME Section XI 2000 Addenda of the Code. However, the flaw tolerance evaluation was not incorporated into the Code, the reason being that typically wall thickness of pump casings is much larger compared to the pressure and there are very few transient loads, so the flaw tolerance is very high.

The AMP relies on requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1 including the alternative requirements of ASME Code Case N-481 for pump casings;
(ii) Guidance in the letter dated May 19, 2000, from Christopher Grimes, NRC, to Douglas Walters, NEI, and research data presented in NUREG/CR-4513, Rev. 1, *Estimation of Fracture Toughness of Cast Stainless Steels during Thermal Aging in LWR Systems*; and
(iii) The description of EVT-1 found in BWRVIP-03, Rev. 6, for BWRs and MRP-228 for PWRs.

4.2.12.2 Observations from Ginna

Ginna performed a plant-specific leak-before-break (LBB) analysis for the reactor coolant system piping and the licensee's evaluation confirmed the stability of postulated through-wall flaws in CASS piping components, as discussed in the SER. This LBB analysis is documented in WCAP-15837 and the licensee's plant-specific flaw tolerance analysis for pump casing is

described in WCAP-15873. These evaluations conclude that the fracture toughness of the CASS components remains adequate for the PEO (60 years). In addition to these flaw tolerance evaluations consistent with the GALL Report, the licensee credited the ongoing ASME Section XI ISI examinations for managing loss of fracture toughness of CASS piping and piping components. The Ginna plant OpE also indicates that ISI has not revealed any indication on the CASS piping or piping components.

LRA Tables 3.1.1.A and 3.2.1.A and SER Tables 3.1A-1 and 3.2A-1 for NMP-1 indicate that this AMP is not applicable because NMP-1 does not have CASS piping and fittings.

4.2.12.3 Effectiveness of AMP XI.M12 to Meet Its Objective

The draft AEA reports from the visit to Ginna were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.12, "AMP Worksheet XI.M12 Thermal Embrittlement of CASS." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.12.4.

4.2.12.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not clearly state that the screening criteria for determining the susceptibility to thermal aging embrittlement of CASS materials is not applicable to ASME SA-351 Grades CF3, CF3A, CF8, CF8A, CF3M, CF3MA, and CF8M materials with ≥0.2 wt. % niobium, and that the acceptance criteria proposed in the GALL AMP for performing flaw tolerance evaluations for thermally aged CASS materials is not applicable for materials with greater than 25% ferrite.

(b) The program description does not include a clear statement that licensees who manage thermal aging effects on CASS materials by performing a component specific flaw tolerance evaluation should provide documentation that the CASS materials meet the ferrite limit of the GALL Report, and that potential effects of plant modifications have been considered in the flaw tolerance evaluation.

(c) The program description does not clarify that the flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with ASME Code, Section XI, IWB-3640 procedures for submerged arc welds (flux welds), disregarding the ASME Code restriction of 20% ferrite.

The AMPs implemented by NMP-1, and by most of the BWR license renewal applicants in general, have been consistent with the GALL AMP XI.M4. Therefore, there have been no industry-proposed exceptions or enhancements to this AMP.

No good practices or strengths of the AMP were identified in this review. In addition, information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.12.3.2 Effectiveness and Implementation of AMP XI.M12

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The scope of program does not clearly state that the screening criteria for susceptibility to thermal aging embrittlement are not applicable to ASME SA-351 Grades CF3, CF3A, CF8, CF8A, CF3M, CF3MA, and CF8M CASS materials with ≥0.2 wt. % niobium. It should clarify that "niobium-containing steels" does not mean ASME SA-351 CF8C CASS materials.

(b) The scope of program does not provide clear guidance for managing the effects of thermal embrittlement for pump casing. In particular, this affects licensees who committed to implement the GALL, Rev. 0, AMP and followed the alternative requirements of ASME Code Case N-481 for pump casing (the Code Case was annulled in 2004 and the flaw tolerance evaluation was deleted).

(c) It is unclear from the description in the scope of program and acceptance criteria whether the flaw tolerance evaluations should be performed using the fracture toughness of the thermally aged CASS material or thermally aged weld or both.

(d) The acceptance criteria does not clearly state that to confirm applicability of the GALL AMP the applicant should provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content.

4.2.12.4 Recommendations for Subsequent License Renewal

4.2.12.4.1 Good Practices or Strengths of AMP XI.M12

No specific good practice was identified during the review.

4.2.12.4.2 Areas of AMP XI.M12 for Further Consideration/Enhancement

<u>Program Description</u>:

M12.0-1: *Recommendation*: Revise the program description to include clarify that for CASS materials with more than 25% ferrite or that contain greater than 0.2 wt. % niobium, flaw evaluation is on a case-by-case basis. In addition, clarify that flaw tolerance evaluation is performed in accordance with the ASME Section XI, Subsection IWB and the guidance provided in acceptance criteria of this program.
***Technical Basis*:** As mentioned in Section 4.2.12.1, this program is not completely applicable for CASS materials with more than 25% ferrite content or containing greater than 0.2 wt. % niobium. For such steels, flaw tolerance evaluation is performed on case-by-case basis.

Although this information is included in either the scope of program or acceptance criteria program element, it would be prudent to include it in the program description.

M12.0-2: *Recommendation*: Revise the program description to include clear guidance for licensees who manage thermal aging effects on CASS materials by performing a component specific flaw tolerance evaluation, to provide documentation that the CASS materials meet the ferrite limit of the GALL Report, and discuss potential effects of plant modifications on the flaw tolerance evaluation.
***Technical Basis*:** Several license renewal applicants, including both Ginna and NMP-1, use option (c) for qualifying potentially susceptible CASS materials and perform a component-specific flaw tolerance evaluation for CASS piping, as well as for CASS pump casings, to meet the requirements of ASME Code Case N-481. Typically, the documents that contain these flaw evaluations are referenced in the applicant's LRAs for extended operation (e.g., Ginna refers to WCAP-15837 and WCAP-15873 for evaluations for piping and pump casing, respectively). However, most LRAs do not provide details about whether all CASS components had less than 25% ferrite or whether the applicant followed the flaw tolerance methodology recommended in the GALL Report. Information presented in an EPRI report (EPRI report 1019128, Dec. 2009) indicates that at least 8% of the heats of CF-8M CASS used in seven PWR units have ferrite content greater than 25%. To confirm applicability of GALL AMP XI.M12, the licensee should be requested to provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content. This list should be included either in the LRA or in supporting documents made available to NRC reviewers during plant audit. In addition, the LRAs typically do not clarify whether any plant modifications such as EPU had any potential effect on the flaw tolerance evaluations.

M12.0-3: *Recommendation*: Revise the program description to clarify that the Section XI, IWB-3640 procedures for submerged arc welds (SAWs) should be used to account for thermal aging degradation of fracture toughness of CASS materials.
***Technical Basis*:** In GALL, Rev. 2, option (c) of this AMP states that aging management is accomplished through "a component-specific flaw tolerance evaluation in accordance with the ASME Code, Section XI, 2004 edition," which seems to suggest that a flaw tolerance evaluation in accordance with 2004 edition of the ASME Code is acceptable. This is misleading or confusing because the current ASME Code requirements do not account for the effects of thermal aging degradation of fracture toughness of CASS materials. The description should state clearly that the Section XI, IWB-3640 procedures for <u>SAWs should be used to account for thermal aging degradation of fracture toughness</u>. These details are described later in "acceptance criteria," which states, "Flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with ASME Code, Section XI, IWB-3640 <u>procedures for SAWs, disregarding the ASME Code restriction of 20% ferrite</u>."

1. <u>Scope of Program</u>:

M12.1-1: *Recommendation*: Revise the scope of program to clarify that the screening criteria for susceptibility to thermal aging embrittlement are not applicable to ASME SA-351 Grades CF3, CF3A, CF8, CF8A, CF3M, CF3MA, and CF8M CASS materials with ≥0.2 wt. % niobium.
***Technical Basis*:** The screening criteria for susceptibility to thermal aging embrittlement are not applicable to niobium-containing steels; such steels require evaluation on a case-by-case basis. Note that this statement does not mean Nb-bearing CASS materials (e.g., CF8C), but CF3, CF8, or CF8M grades of CASS that may contain ≥0.2 wt. % niobium. The chemical composition of ASME SA-351 Grades CF3, CF3A, CF8, CF8A, CF3M, CF3MA, and CF8M does not specify

any limit for the niobium content of the material. Research data indicate that the fracture toughness of thermally embrittled CASS materials with 0.2 wt. % niobium is significantly lower than that of CASS materials with insignificant amounts of niobium. The source of niobium is generally the niobium-bearing steels (e.g., Type 347) that may be used as scrap in preparing the castings. Therefore, although CASS materials produced in the United States may not contain significant amounts of niobium, CASS products procured from Europe or Asia, where Type 347 steels are used extensively and are likely to be used as scrap, may contain >0.2 wt. % niobium.

M12.1-2: *Recommendation*: Revise the scope of program to provide clear guidance for managing the effects of thermal embrittlement for pump casing and valve bodies (e.g., Code Case N-481 for pump casing has been annulled and provide the basis for this change).
***Technical Basis*:** For valve bodies and pump casings the GALL AMP, Rev. 0, specifies demonstration of compliance with the requirements of Code Case N-481 as the primary aging management approach, with supplemental visual inspections, and if this approach fails, then ASME Section XI volumetric ISI is specified as the alternative. However, in GALL, Rev. 1, the Code edition was changed to 2001 (and changed to 2004 edition in Rev. 2), which requires only surface examination for the pump casing welds, and CC N-481 was annulled on March 28, 2004 because it was incorporated into the ASME Code, with the exception of the flaw tolerance evaluation, which was deleted. The reason for deleting the flaw tolerance was primarily that the flaw tolerance evaluations performed to date for LRAs have shown very large margins of safety

M12.1-3: *Recommendation*: Revise the scope of program to include clarification about whether the flaw tolerance evaluations should correctly be performed using the fracture toughness of the thermally aged weld.
***Technical Basis*:** Code Case N-481, discussed above, provides alternative requirements in lieu of the volumetric examinations specified in Table IWB-2500-1, Examination Category B-L-1, Item 12.10 for pump casing welds (1997 or earlier editions of the Code). In addition to visual examinations of internal and external surfaces of pump casing, to demonstrate the safety and serviceability of the pump casing, it includes a flaw tolerance evaluation in accordance with N-481(d), considering thermal aging embrittlement and other processes that may degrade the properties of the pump casing. Typically, the lower-bound saturation fracture toughness of the thermally embrittled pump casing material is used in these N-481 analyses.

Extensive research data indicates that this lower-bound toughness of CASS materials with up to 25% ferrite is similar to that for SAWs or shielded metal arc welds with up to 20% ferrite. However, the fracture toughness of the thermally aged weld and not the CASS material represents the true lower bound toughness for the pump casing. Therefore, flaw tolerance evaluations should correctly be performed using the fracture toughness of the thermally aged weld. In addition, in view of the significantly lower fracture toughness of thermally aged welds (e.g., 40% lower fracture toughness), the justification for deleting the flaw tolerance evaluations for pump casings may need to be re-examined.

2. Preventive Action:

Not applicable.

3. Parameters Monitored/Inspected:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M12.6-1: *Recommendation*: Revise the acceptance criteria to clearly state that to confirm applicability of GALL AMP the applicant should provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content.
***Technical Basis*:** The acceptance criteria program element clearly states, "Flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with ASME Code, Section XI, IWB-3640 procedures for SAWs, disregarding the ASME Code restriction of 20% ferrite. […] Flaw tolerance evaluation for piping with >25% ferrite is performed on a case-by-case basis by using the applicant's fracture toughness data." This is a key condition that should be used by the licensees to check whether or not the GALL AMP is applicable for the CASS components in its plant. However, very few LRAs have provided a clear statement about whether heats of CASS with greater than 25% ferrite are used in its plant. To confirm applicability of GALL AMP XI.M12, the applicant should be requested to provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content. This list should be included either in the LRA or in supporting documents made available to NRC reviewers during plant audit. See recommendation M12.0-2 for additional information.

M12.6-2: *Recommendation*: Revise the acceptance criteria to include clarification about whether the flaw tolerance evaluations should correctly be performed using fracture toughness of the thermally aged weld.
***Technical Basis*:** The XI.M12 AMP recommends either a qualified visual EVT-1 or UT examination to detect cracks or a plant-specific or component-specific flaw tolerance examination to demonstrate that the thermally embrittled material has adequate fracture toughness. In the flaw tolerance evaluation, the allowable flaw size is typically based on the lower-bound saturation fracture toughness of the thermally embrittled pump casing CASS material. Extensive research data indicates that this lower-bound toughness of CASS materials with up to 25% ferrite is similar to that for SAW or shielded metal arc welds with up to 20% ferrite.

However, the saturation fracture toughness of thermally embrittled CASS material may not be the lower bound for the pump casings. As discussed above, the fracture toughness of the thermally aged weld will be lower than that for the thermally aged CASS material. Clarification is needed regarding whether the flaw tolerance evaluations should be performed using the fracture toughness of the thermally aged weld. See recommendation M12.1-3 for additional information.

7. <u>Corrective Actions</u>:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.13 Loose Part Monitoring (XI.M14)

4.2.13.1 Objective and Scope of AMP XI.M14

The objective of this AMP is to detect and monitor loose parts in light-water reactor (LWR) power plants, during normal operation, so as to enable early indication of component degradation, especially within the primary coolant system. The aging related degradation addressed by this AMP includes any impact on safety related functionality likely to occur from the loosening (or disengagement or breakage) of a part due to any aging effect such as wear/impact from mechanical or flow-induced vibrations, loss of preload, fretting, or localized (surface) cracking – in addition to that from any inadvertently introduced part or piece of hardware (unaccounted or unidentified foreign object). The impact itself could include wear elsewhere due to the loose part, blockage of flow, or jamming of critical component(s), while in service.

Note, however, that Rev. 0 of the GALL Report (NUREG-1801, 2001) appears to have credited this AMP only for managing the loss of preload due to stress relaxation (in materials ranging from generic SS to generic Ni alloys to Gr. B-8 SS, to A-286 and X-750) in the AMR line items in reactor vessel, vessel internals, and RCS (in Chapter IV of the GALL Report), in conjunction with GALL AMP XI.M1. This scope was further reduced in Rev. 1 of the GALL Report (NUREG-1801, 2005), where no AMR item was listed for this AMP. As noted in NUREG-1950 (basis document for GALL, Rev. 2), AMP XI.M14 was eliminated on the basis of lack of relevance and very limited previous usage in submitted LRAs.

The original AMP relies on an inservice loose part monitoring (LPM) program based principally on the recommendations from the ASME operation and maintenance standards and guides of 1997, Part 12, “Loose Part Monitoring in Light-Water Reactor Power Plants,” and includes by reference the guidance from NRC RG 1.133, Rev. 1.

4.2.13.2 Observations from Ginna

At NMP-1, the “Loose Part Monitoring” AMP XI.M14 of the GALL Report, Rev. 0, and Rev. 1, was stated to be not applicable as it was not credited for aging management, and the program was not implemented. Ginna also does not implement the XI.M14 program as an aging management activity, although its LRA describes “Loose Part Monitoring” in Section B2.1.19, which lists 12 AMPs at Ginna that relate to the reactor coolant system and reactor vessel internals. The LRA also notes that there is a loose parts monitoring system employed for the steam generators, called the digital metal impact monitoring system (DMIMS), which is not considered to be an aging management program but rather a reactive measurement system to detect failed or foreign material exclusion (FME) components that have inadvertently entered the steam generators.

During the Ginna audit, the staff noted that the purpose of Ginna’s counterpart (B2.1.19) to GALL Report AMP XI.M14 is to rely on inservice monitoring to detect and monitor loose parts in the power plant, in lieu of measures to monitor and detect metallic loose parts with acoustic signal data analysis, as intended in the GALL Report, Rev. 0. This revision of the GALL Report, in the Chapter 4 AMR line items (reactor vessel, internals, and RCS) using AMP XI.M14, always coupled it with GALL Report AMP XI.M1 to manage the loss of preload due to stress relaxation. The GALL Report, Rev. 1, did not apply AMP XI.M14 to any AMR line items. However, based on acceptable plant-specific experience, as noted by Ginna in response to an earlier LRA request for additional information (RAI) 2.2.2-4 (May 13, 2003), and the use of AMP XI.M1 to manage loss of preload due to stress relaxation, the staff agreed in the license renewal SER

that loose parts monitoring did not appear necessary. The staff's SER and subsequent inspection/audit reports did not evaluate this program for license renewal, since it was not credited for any AMR items for SSCs within the scope at Ginna.

Also, during Ginna audit, the staff's search of the ePIC (Electronic Performance Improvement Center) database, looking at CR and corrective action program (CAP) records for any significant incidence of loose parts in the primary coolant system and the reactor vessel internals, found only that there were various cases of high false alarm rates, over-sensitivity, and limited capability for interpreting alarms and signals. The records indicated that there has been work to improve the signal to noise ratio (EPRI NP-5743).

4.2.13.3 Effectiveness of AMP XI.M14 to Meet Its Objective

The audit report on the assessment of AMP effectiveness from the visit to Ginna was as reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.13, "AMP Worksheet XI.M14 Loose Part Monitoring." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.13.4.

4.2.13.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description of (GALL, Rev. 1) AMP XI.M14 does not state its objective, nor does it include which aging effects caused by what aging degradation mechanism are being managed by the AMP.

(b) The GALL AMP description does not address concerns and guidance from the referenced Reg. Guide 1.133 (Rev.1) and later industry guidelines (EPRI NP-5743, 1988).

This AMP was not implemented at NMP-1 (or NMP-2). In addition, the program at Ginna does not employ LPM for the reactor vessel/internals and reactor coolant primary systems; instead it lists several other AMPs related to the RCS and reactor vessel internals. As such, the Ginna AMP is not consistent with GALL AMP XI.M14, and how most, if not all, of the other listed AMPs provide for a timely or an early detection and/or monitoring of any loose part during operation is unclear. Since the experience with, and/or implementation of, this (original) GALL AMP is limited, in effect, its adequacy cannot be evaluated. As such, in the absence of well-supported and documented basis for elimination of this program, the underlying loose part related degradation during the PEO, and especially the online monitoring aspect, are being managed through the presumed total absence of significant loose parts in the entire RCS at any time.

No good practices or strengths of the AMP or its alternative were identified in this review.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.13.3.2 Effectiveness and Implementation of AMP XI.M14

The effectiveness of the AMP and the results of AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," does not clarify that the degradation of concern addressed by this AMP, in contrast to other related inspections/AMPs, can be system-wide (i.e., its scope covers unfocused or unspecified areas), which is significant since the damage due to loose parts or flow pattern distortions is not limited, a priori, to any specific or known location; and that the monitoring is online and real-time.

(b) Program Element 3, "Parameters Monitored/Inspected," relies on the acoustic emission process that may have contributed in the past to the costs associated with false positives resulting in the abandonment of this AMP, which may be both premature and unrelated to the program objective.

(c) Program Element 10, "Operating Experience," notes that the LPM program is extensively and effectively used by the industry, which seems to contrast the basis for its elimination stated in NUREG-1950. Furthermore, lessons learned from prior industry experience and regulatory guidance seem to suggest the significance of LPM for the PEO. In addition, since there is no specific requirement for this AMP (following Rev. 2 of the GALL Report), the licensee may not have explicit plans to address some of the potential issues that are otherwise likely to be addressed to some extent by other existing programs.

4.2.13.4 Recommendations for Subsequent License Renewal

4.2.13.4.1 Good Practices or Strengths of AMP XI.M14

No specific good practice was identified during the review.

4.2.13.4.2 Areas of AMP XI.M14 for Further Consideration/Enhancement

Program Description:

M13.0-1: ***Recommendation*:** Revise program description of GALL, Rev. 1, AMP XI.M14 stating its objective, which aging effects caused by what aging degradation mechanism are to be managed, and incorporate related and updated basis documents: RG 1.133, Rev. 1 (Reviewed 11/2009); EPRI NP-5743 (1988); IAEA-TECDOC-1557 (Update, June 2007); IAEA-NP-T-1.2 (Part 2, 2008); and NUREG/CR-6992 (October 2009).

***Technical Basis*:** The GALL AMP should address concerns and guidance from the referenced RG 1.133 (Rev.1), later industry guidelines (EPRI NP-5743, 1988), and relevant updated technology and industry efforts important to the objective of the (original) AMP.

1. <u>Scope of Program</u>:

M13.1-1: *Recommendation*: Reconsider an appropriately scoped AMP for the LPM of the reactor vessel, internals, and the primary pressure boundary, incorporating better/more reliable techniques of online monitoring as they are developed, and taking into consideration the guidance from latest industry documents as well as results from international implementations of LPM programs.
***Technical Basis*:** The primary intent of the original AMP was to provide early indications of component degradation while the plant was in (normal) operation. The monitoring (and detection) program deals with the flow-induced vibrations leading to wear (loss of material) and/or fretting as the primary aging degradation, with LPM that includes the RCS in general. The resulting degradation of concern addressed by LPM, in contrast to other related inspections/AMPs, can be system wide (i.e., unfocused or unspecified areas are generally covered by LPM), which is significant since the damage due to loose parts or flow pattern distortions is not limited, a priori, to any specific or known location. In addition, the monitoring is typically online and real-time. These aspects of the aging degradation are otherwise not addressed if LPM (or similar) programs are not included in the AMP structure. The unspecified nature/location of the damage, as intended to be covered by the original AMP and by RG 1.133 (Rev. 1), also means that safety significance (of degradation) cannot be ruled out, a priori – without assurance that there will be no unidentified loose parts remaining, either due to maintenance or operational activities, that would degrade the functionality of any safety-related system(s) prior to identification and correction in a timely manner.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

M13.3-1: *Recommendation*: Provide guidance on alternate techniques with more reliable online monitoring and parameters to be monitored for detection of loose parts or anomalous flow/vibration response, based on the state-of-the-art monitoring methods and implementation experience.
***Technical Basis*:** The instance of, and costs associated with, false positives generated via acoustic emission based monitoring in past implementations may have resulted in the abandonment of this AMP without addressing the original concerns and program objective, both of which have increased relevance (significance) for the PEO and EPU. Updated technology and refined equipment capable of acceptable performance would be a better approach than basing the program elimination on inadequacy of a monitoring technique.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

M13.10-1: ***Recommendation*:** Survey industry-wide response to confirm or adjust the impact of eliminating this monitoring program, or its non-relevance for the PEO including any EPU. Reconcile the prior stated usage of LPM and regulatory guidance, current developments in online monitoring implementations, and the need (or basis) for elimination of this AMP.
***Technical Basis*:** The original AMP notes that LPM is extensively and effectively used by the industry, and its need was initially discussed in RG 1.133 (Rev. 1), which indicates the AMP's relevance (significance) for the PEO. It is possible that the concerns expected to be addressed by LPM – from the original AMP and the earlier RG 1.133 (Rev. 1) – may be addressed in an alternate manner on a plant-specific basis, and/or determined by an engineering analysis to be not significant (at least from a safety point of view). This could provide the technical basis for elimination of this AMP, although judgment is needed to extrapolate past experience (i.e., any related non-incidence) that could be applicable during the PEO. In either case, it may be useful to review industry experience (including any LERs) by surveying (a) any instance(s) of loose parts and/or associated damage, or unexpected locations/damage identified in the RCS and core internals; (b) actions or measures taken to address these instances; (c) any approach or technique in use to locate/identify such unspecified damage as may result from loose parts (including foreign objects) and/or flow anomalies within the RCS/reactor pressure vessel (RPV); and (d) any plant-specific procedures, precautions, and practices in place to ensure that such (unspecified) degradation does not occur or is adequately managed to maintain the required functionality during normal and emergency operation.

4.2.14 Neutron Noise Monitoring (XI.M15)

4.2.14.1 Objective and Scope of AMP XI.M15

The objective of this AMP is to monitor the loss of axial preload due to stress relaxation at the core support barrel (CSB) upper support flange in PWRs in materials such as SS and nickel alloys, during normal operation, so as to enable early indication of component degradation and to minimize its impact on impairment of CSB functionality. The loss of axial restraint may arise from long-term changes resulting from abnormal wear at the reactor vessel core barrel mating surface or short-term changes due to improper installation of the reactor internals. As such, the monitoring and detection program also deals with the flow-induced vibrations leading to wear (loss of material) likely to affect the core internals during normal operation due to anomalous flow patterns. The online monitoring makes use of the differential neutron noise (ex-core neutron flux) as a pattern recognition tool.

Note, however, that Rev. 0 of the GALL Report (NUREG-1801, 2001) appears to have credited this AMP only for managing the loss of preload due to stress relaxation (in materials including SS and Ni alloys) in two AMR line items in the reactor vessel, vessel internals, and RCS (in Chapter IV of the GALL Report), in conjunction with GALL AMPs XI.M1 and XI.M14. This scope was further reduced in Rev. 1 of the GALL Report (NUREG-1801, 2005) where no AMR item was listed for this AMP. As noted in NUREG-1950 (basis document for GALL, Rev. 2), AMP XI.M14 was eliminated on the basis of lack of relevance and very limited previous usage in submitted LRAs.

The original AMP relies on an inservice neutron noise monitoring (NNM) program based principally on the recommendations from the ASME operation and maintenance standards and guides from 1997, Part 5, “Inservice Monitoring of Core Support Barrel Axial Preload in Pressurized Water Reactors Power Plants.” The NNM program activities include detection and analysis of fluctuating neutron flux signals (ex-core), and diagnostics if an anomalous response is detected.

4.2.14.2 Observations from Ginna

This AMP is not applicable to NMP-1 since it is a BWR. The program monitors the excess neutron detector signals due to core motion to detect and monitor significant loss of axial preload at the core support barrel’s upper support flange in PWRs. Ginna does not have a separate aging management program corresponding to AMP XI.M15 of the GALL Report, Rev. 0. Instead, Section B2.1.20 of the LRA notes that the changes in reactor vessel internal support structures (such as the core support barrel’s upper support flange) are managed by its other AMPs, namely, the “ASME Section XI, Subsections IWB, IWC, IWD, Inservice Inspection” (LRA Section B2.1.2) and the “Reactor Vessel Internals” (LRA Section B2.1.27).

During the Ginna audit, the staff noted that the GALL Report, Rev. 0, had only two Chapter IV AMR line items (reactor vessel, internals, and RCS) that invoked AMP XI.M15, both of which were coupled with AMP XI.M1 and AMP XI.M14 to manage the loss of preload. The staff further noted that in GALL Report, Rev. 1, AMP XI.M15 was not used for any AMR line items, and in NUREG-1950 (the basis document for the GALL Report, Rev. 2), AMP XI.M15 was eliminated due to lack of relevance and very limited previous usage in submitted LRAs. During the audit at Ginna, the staff searched the licensee’s ePIC database containing CR/CAP records to verify if any increase in clearances and wear of mating surfaces at the barrel upper support area were observed in related inspections or OpE. Of interest was how these observations were evaluated in relation to the loss of axial preload consideration, and in relation to the alternate

two AMPs that B2.1.20 references. The Ginna staff stressed that the ISI program examined head bolting and hold-down springs, and that the leakage monitoring detected any leakage into the space between the related O-rings. Any increase in clearances and wear of mating surfaces at the barrel upper support area (between inspections) are assumed to be small enough to have little impact on the loss of preload and/or axial restraint, and to have been rectified if necessary during the next outage.

4.2.14.3 Effectiveness of AMP XI.M15 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1414, "AMP Worksheet XI.M15 Neutron Noise Monitoring." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.14.4.

4.2.14.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) Several recent publications (e.g., Ansari, S.A. et al., "Detection of Flow-Induced Vibration of Reactor Internals by Neutron Noise Analysis," IEEE Transactions on Nuclear Science, Vol. 55, No. 3, June 2008; IAEA, TECDOC-1557, "Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: PWR Internals," 2007 Update, June 2007) and related international programs for online monitoring provide an opportunity to update the AMP description, which incorporates findings and guidance (from these programs and publications) relevant to the AMP objectives for PEO and effects of EPU operation.

This AMP was not implemented at Ginna. Instead, the Ginna AMP relies on ASME Section XI ISI to manage the CSB interface changes during the periodic examinations. As such, the Ginna AMP is not consistent with GALL AMP XI.M15. Since the experience with, and/or implementation of, this (original) GALL AMP is limited in effect, its adequacy cannot be evaluated. As such, in the absence of a well-supported and documented basis for the elimination of this program, the underlying related degradation during PEO, especially the online monitoring aspect and any EPU operation, are addressed only indirectly and in a limited way.

No good practices or strengths of the AMP or its alternative were identified in this review.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.14.3.2 Effectiveness and Implementation of AMP XI.M15

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," should clarify whether periodic inspections are adequate, and how to address the original intent of early detection and online monitoring for anomalous vibratory and flow changes affecting the reactor internals including the CSB, given the possibility of EPU operation during the PEO and improper installation after a periodic ISI. Instead of eliminating the AMP, a revised scope should be considered, based on incorporating better/more reliable techniques of online monitoring as they are developed.

(b) Program Element 5, "Monitoring and Trending" should reconsider the need for this program or evaluate the basis for the elimination of this AMP.

(c) Program Element 10, "Operating Experience," should confirm the adequacy of periodic inspections to limit or eliminate the need for online monitoring of CSB and internals and related early detection of degradation, and assess the potential for future reliability based on only the past performance, during the PEO and EPU operation.

4.2.14.4 Recommendations for Subsequent License Renewal

4.2.14.4.1 Good Practices or Strengths of AMP XI.M15

No specific good practice was identified during the review.

4.2.14.4.2 Areas of AMP XI.M15 for Further Consideration/Enhancement

Program Description:

M14.0-1: *Recommendation*: Reassess the reasons for eliminating this AMP and its relevance for PEO, including EPU operation, given the updated technology for online monitoring. Revise program description of GALL, Rev. 1, AMP XI.M15 to incorporate the results of reassessment. ***Technical Basis*:** The relevance/significance of the early detection of degradation and online monitoring for conditions unrelated or independent of any periodic inspection result, with impact on CSB and reactor internals, is likely to be greater during the PEO and EPU operation. Updated technology reflected in recent publications (e.g., Ansari, S.A. et al., "Detection of Flow-Induced Vibration of Reactor Internals by Neutron Noise Analysis," IEEE Transactions on Nuclear Science, Vol. 55, No. 3, June 2008; IAEA, TECDOC-1557, "Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: PWR Internals," 2007 Update, June 2007) and related international programs for online monitoring suggest that the original AMP objectives are valid and manageable during PEO.

1. Scope of Program:

M14.1-1: *Recommendation*: Reconsider an appropriately scoped AMP for online monitoring to address the original intent of early detection of anomalous vibratory and flow changes affecting the reactor internals including the CSB, given the possibility of EPU operation during the PEO, and incorporating better/more reliable techniques of online monitoring as they are developed. ***Technical Basis*:** The possibility of abnormal wear and/or improper installation can lead to

impairment of functionality during operation without the benefit of early detection for timely action. The ISI and vessel internals programs do not cover the intended monitoring aspect and may give only an indirect indication of aging-related loss of preload during periodic inspections.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

M14.3-1: *Recommendation*: Provide guidance on alternative techniques or analytical methods for more reliable online monitoring and parameters to be monitored for early detection of degradation of response (anomalous vibration or flow patterns) for the reactor internals, based on the state-of-the-art monitoring methods and updated online monitoring implementation experience.
***Technical Basis*:** The monitored parameter space should be more acceptable if appropriate thresholds are possible to exclude or identify truly anomalous responses while addressing any nonlinearly accelerating degradation during otherwise normal operation of the reactor internals and CSB.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

M14.10-1: *Recommendation*: Survey industry-wide experience and practices to confirm or adjust the impact of eliminating this monitoring program or its non-relevance to PEO. Confirm the method or assessment used to determine and/or manage the loss of axial preload based on periodic inspections performed under the ISI and reactor vessel internals AMP. Provide guidance on possible design modifications that would eliminate or substantially reduce the

possibility of degraded condition (e.g., see IAEA-TECDOC-1557).
***Technical Basis*:** Further work is relevant to assess the significance of this online monitoring program based on the plant database and OpE (e.g., to verify if any increase in clearance[s] and wear of mating surfaces at the barrel upper support area were observed in the related inspections or past history of operation). In addition, in cases of EPUs coupled with the possibility of LTO, the use of effective online monitoring would be significant. It would be relevant to the possibility that any increase in clearance(s) and wear of mating surfaces at the barrel upper support area (between inspections) is assumed to be small enough to have little impact on the loss of preload and/or axial restraint, and to have been rectified if needed during the outage to have adequate preload during the subsequent period of operation. If confirmed, this could help provide a basis for reduced need for this AMP.

4.2.15 PWR Vessel Internals (XI.M16A)

4.2.15.1 Objective and Scope of AMP XI.M16A

The objective of this AMP is to manage the effects of age-related degradation mechanisms that are applicable in general to the PWR RVI components at the facility. These aging effects include: (a) loss of material due to various forms of corrosion; (b) various forms of cracking, including SCC, which also encompasses PWSCC, IASCC, or cracking due to fatigue/cyclical loading; (c) loss of material induced by wear; (d)decrease in fracture toughness due to either thermal aging or neutron irradiation embrittlement; (e) changes in dimension due to void swelling; and (f) loss of preload due to thermal and irradiation-enhanced stress relaxation or creep.

The program conforms to the definition of a sampling-based condition monitoring program, as defined by the Branch Technical Position RSLB-1, with periodic inspection of highly affected internals-locations. The MRP-227 guidance for selecting vessel internal components for inclusion in the inspection sample is based on a four-step ranking process. The reactor internals for all three PWR designs are assigned to one of the following four groups: Primary, Expansion, Existing Programs, and No Additional Measures components. The results provide a set of Primary Internals Component locations for each PWR design that are expected to show leading indications of the degradation effects, with another set of Expansion Internals Component locations that are specified to expand the sample should the indications be more severe than anticipated. The degradation effects in a third set of locations are deemed to be adequately managed by existing programs, such as ASME, Section XI, Examination Category B-N-3, examinations of core support structures. A fourth set of internals locations is deemed to require no additional measures.

The scope of the program includes the response bases to applicable AAIs on the MRP-227 methodology, and any additional programs, actions, or activities that are discussed in these AAI responses and credited for aging management of the applicant's vessel internal components. The AAIs are identified in the staff's safety evaluation on MRP-227 and include applicable action items for meeting the assumptions that formed the basis of the MRP's augmented inspection and flaw evaluation methodology (as discussed in Section 2.4 of MRP-227), and NSSS vendor-specific or plant-specific AAIs as well. The responses to the AAIs on MRP-227 are provided in Appendix C of the LRA.

To ensure that potential detrimental effects of cracking would be adequately managed such that the intended functions of the PWR vessel internal components are maintained during the PEO, the AMP relies on the following AMAs:

(1) Implementation of the MRP-227 report (EPRI 1016596) and MRP-228 report (EPRI 1016609) to manage the aging effects on the reactor vessel internal components. The program applies the guidance provided in MRP-227 for inspecting, evaluating, and, if applicable, dispositioning nonconforming reactor vessel internal components at the facility. The program also includes future industry OpE as incorporated in periodic revisions to MRP-227.

    For the management of cracking, the program monitors for evidence of surface-breaking linear discontinuities if a visual inspection technique is used as the NDE method, or for relevant flaw presentation signals if a volumetric UT method is used as the NDE method. For the management of loss of material, the program monitors for gross or abnormal surface

conditions that may be indicative of loss of material occurring in the components. For the management of loss of preload, the program monitors for gross surface conditions that may be indicative of loosening in applicable bolted, fastened, keyed, or pinned connections. The program does not directly monitor for a decrease in fracture toughness that is induced by thermal aging or neutron irradiation embrittlement, or by void swelling and irradiation growth; instead, the impact of a decrease in fracture toughness on component integrity is indirectly managed by using visual or volumetric examination techniques to monitor for cracking in the components and by applying applicable reduced fracture toughness properties in the flaw evaluations if cracking is detected in the components and is extensive enough to warrant a supplemental flaw growth or flaw tolerance evaluation under the MRP-227 guidance or ASME Code, Section XI requirements. The program uses physical measurements to monitor for any dimensional changes due to void swelling, irradiation growth, distortion, or deflection.

(2) Monitoring and control of reactor water chemistry based on industry guidelines contained in EPRI 1014986 (PWR Primary Water Chemistry Guidelines – Revision 6) and EPRI 1016555 (PWR Secondary Water Chemistry Guidelines – Revision 7).

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1;
(ii) MRP-227-A, EPRI 1022863, *Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines*;
(iii) MRP-228, EPRI 1016609, *Materials Reliability Program: Inspection Standard for PWR Internals*;
(iv) WCAP-17096-NP, Rev. 2, *Reactor Internals Acceptance Criteria Methodology & Data Requirements*; and
(v) EPRI 1014986, *PWR Primary Water Chemistry Guidelines, Revision 6*, Volumes 1 and 2.

4.2.15.2 Observations from Ginna

This AMP is not applicable to NMP-1 because it is a BWR. The Reactor Vessel Internals (RVI) program approved for Ginna in the SER was a plant-specific version of the AMP in the GALL Report, Rev. 0. The LRA stated that Ginna would monitor ongoing industry initiatives and committed to modify its program "appropriately to incorporate industry lessons learned." The program as identified in the LRA is based on augmentation of the ASME Section XI ISI Program for certain susceptible or limiting components or locations. One aspect of the program cited in the LRA was augmentation to enable detection of fine cracks in non-bolted components with enhanced visual examination methods capable of resolving 0.0005-in. features of interest.

During the Ginna audit, the licensee stated that it had implemented the initial inspection under its program consistent with Materials Reliability Program (MRP) MRP-227, Rev. 0, and will update its program through a comparison with MRP-227-A to determine the path forward to achieve consistency with MRP-227-A. During the Ginna audit, the licensee stated that it may require deviations which it will justify through the MRP-227-A process.

Ginna stated that it will withdraw its RVI program submitted for NRC review and approval and re-submit it within 1 year consistent with MRP-227-A (note, the new submittal is dated September 28, 2012). Further details are available in the AEA TLR, ML13122A009.

The Ginna PWR Vessel Internals program inspections included significant interactions with a U.S. Department of Energy (DOE) program that is addressing plant long-term operation. Therefore, the results of the inspections will be provided in various reports and papers. In

addition, findings from the inspections will be documented through the MRP process to all PWR licensees, and the inspections modified accordingly.

In 1999, Ginna replaced 56 out of 728 bolts after UTs of the 639 accessible bolts. Although 14 bolts were identified as having indications, laboratory examination of the 54 removed bolts that didn't fail upon removal identified only one with a crack, indicating that the ultrasonic test method employed at that time was conservative. Additional OpE information is contained within ML13122A009. As discussed above, additional changes are being made to make this program consistent with MRP-227-A.

4.2.15.3 Effectiveness of AMP XI.M16A to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to Ginna plant were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy; and, (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.15, "AMP Worksheet XI.M16A PWR Vessel Internals." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.15.4.

4.2.15.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant conclusions from an assessment of the adequacy of the program description are as follows:

(a) The program description and other relevant program elements of the AMP do not include guidance for managing the effects of decrease in fracture toughness due to thermal and neutron embrittlement of CASS reactor vessel internal components.

(b) The program description does not include a statement that the synergistic effects of thermal and neutron embrittlement should be addressed in the program.

(c) The program description does not state that applicants for SLR should provide an assessment of the effect of long-term exposure to neutron irradiation on the mechanical properties of reactor vessel internal components and its impact on the licensing basis.

(d) It appears that clarity is not there that either this AMP or the WCAP-17096 report includes acceptable methodology for estimating reduction in fracture toughness and expressions for crack growth rates for reactor vessel internal materials such as SSs, nickel alloys, and low-alloy steels, including the effects of any plant modifications since the original licensing basis.

(e) The program description does not include guidance regarding the options proposed in RIS 2011-07.

The AMPs implemented by Ginna, and by most of the PWR license renewal applicants in general, are not necessarily reflective of those that will be implement to achieve consistency with MRP-227-A during the PEO. Therefore, there is no industry experience regarding potential exceptions or enhancements to this AMP.

One good practice or strength of the AMP was identified in this review. The use of plant-specific and industry-wide OpE for updating and implementing the program is considered a good practice or strength of the AMP. In addition, information on the possible effects of plant modifications on this AMP was not evaluated in this TLR. This is considered to be an important aspect and may be reviewed in subsequent efforts.

4.2.15.3.2 Effectiveness and Implementation of AMP XI.M16A

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant conclusions from the evaluation are as follows:

(a) The scope of program does not include an evaluation of neutron fluence, for specific reactor vessel internal components to identify specific aging degradation processes that need to be addressed and to establish acceptable methodology for estimating the loss of fracture toughness and crack growth rates for reactor internal components.

(b) The scope of program does not include the following information in its response to AAI #8: (i) identify and verify accessibility of the fatigue-sensitive location;; (ii) adequate inspection technique to detect fatigue cracks;; and, (iii) a postulated flaw tolerance and growth analysis, including the effects of reactor coolant and neutron irradiation environment, to justify the adequacy of the inspection interval.

(c) The scope of program and other relevant program elements of the AMP do not include guidance for managing the effects of a reduction in fracture toughness due to thermal and neutron embrittlement of CASS reactor vessel internal components.

(d) The parameters monitored/inspection program element does not include an assessment of degradation processes based on the total neutron dose for each component.

(e) The acceptance criteria program element does not include validation of the 10-year inspection interval for highly irradiated components, including the effects of plant modifications such as EPU.

4.2.15.4 Recommendations for Subsequent License Renewal

4.2.15.4.1 Good Practices or Strengths of AMP XI.M16A

***Recommendation*:** The use of plant-specific and industry-wide OpE for updating and implementing the program is considered a good practice or strength of the AMP.
***Technical Basis*:** Ginna considered baffle bolt OpE at DC Cook, Beznau (Switzerland),), and Surry and clevis pin insert screw experience from Cook, as well as its plant-specific OpE prior to implementation of its PWR Vessel Internals program. The use of plant-specific and industry-wide OpE for updating and implementing the program is considered a good practice or strength of the AMP.

4.2.15.4.2 Areas of AMP XI.M16A for Further Consideration/Enhancement

Program Description:

M15.0-1: *Recommendation*: Revise program description and other relevant program elements of the AMP to include guidance for managing the effects of a reduction in fracture toughness due to thermal and neutron embrittlement of CASS reactor vessel internal components.
***Technical Basis*:** The program description of GALL AMP XI.M12 states, "Aging management of CASS reactor internal components of pressurized water reactors (PWRs) are discussed in AMP XI.M16A." However, GALL AMP XI.16A does not describe any program for managing the effects of a reduction in fracture toughness due to irradiation and/or thermal embrittlement of CASS materials in PWRs. If such a program is included in MRP-227 guidance, it is not clear whether the program is consistent with the staff-approved AMP XI.M13 in GALL, Rev. 1. This AMP should either include relevant sections of GALL AMP XI.M13 (similar to what was included in GALL, Rev. 2, AMP XI.M9), or clarify that such a program is included in MRP-227 and that staff has reviewed it and found it to be consistent with GALL AMP XI.M13.

In MRP-227, Section 3.3.2, "Categorization and Aging Management Strategy Development," Tables 3-1 to 3-3, the following CASS components are considered *primary components*:
Babcock and Wilcox (B&W) Internals: Core support shield cast outlet nozzle and vent valve discs, and incore monitoring instrumentation (IMI) guide tube spiders.
Westinghouse: control rod guide tube (CRGT) assembly lower flanges.

In addition, the following CASS components are considered *expansion components*:
B&W Internals: CRGT spacer castings.
Combustion Engineering (CE) Internals: Lower core support columns.
Westinghouse: Lower core support column bodies.

M15.0-2: *Recommendation*: As a follow-up recommendation to M15.0-1, while describing the program to manage aging effects of thermal and neutron embrittlement of CASS components, include a statement that the synergistic effects of thermal and neutron embrittlement should be addressed in the program.
***Technical Basis*:** Section A.6.1, "Thermal Embrittlement," of the EPRI MDM (Rev. 1) report states that the synergistic effect of thermal and neutron embrittlement has been identified as a potential concern by the NRC staff (in section XI.M13 of NUREG-1801, Rev.1). However, it further adds that no data have been presented to prove or disprove the existence of such synergistic effects and some researchers discount this possibility since thermal aging affects the ferrite much more than irradiation for relevant neutron doses, and CASS is not expected to receive high enough irradiation doses for an irradiation effect on the austenite to occur. The latter statement in the MDM report is not entirely correct. It is unknown whether the combined effects of thermal aging and neutron irradiation on ferrite would decrease fracture toughness more than that due to thermal aging alone. In addition, neutron embrittlement of austenite starts at 0.5 dpa and fracture toughness can decrease to about 38 MPa $m^{1/2}$ at about 4.5 dpa (at 290–300°C). Several CASS internal components, listed above, are likely to exceed these neutron dose levels during the current license renewal period.

The program to manage the loss of fracture toughness of CASS reactor internal components due to thermal aging embrittlement and neutron embrittlement is essentially AMP XI.M13 of GALL, Rev. 1, and is acceptable. As discussed in M15.0-1, a program based on XI.M13 needs to be included in AMP XI.M16A.

M15.0-3: *Recommendation*: Revise the program description to request that applicants for SLR provide an assessment of the effect of long-term exposure to neutron irradiation on the mechanical properties of reactor vessel internal components and its impact on the licensing basis.
***Technical Basis*:** To ensure that the effects of aging on the reactor vessel internals would be adequately managed so that the components' intended functions would be maintained consistent with the CLB for the PEO, the applicant should review its design basis analyses in its FSAR and other relevant documents, and identify additional TLAAs or design evaluations that may be needed. The MRP-227 report does not provide an assessment of the effect of long-term exposure to neutron irradiation on the mechanical properties of reactor vessel internal components and its impact on the licensing basis. This particularly affects whether the requirements of ASME Code Section III Subsections NB/NG-2160, NB/NG-3121, or NB/NG-3124 that are related to various aging effects on mechanical properties of reactor structural material remain valid during the extended period. The applicant should provide: (a) an assessment of neutron fluence for specific reactor vessel internal components to define threshold fluence for susceptibility to IASCC, neutron embrittlement, void swelling, irradiation creep, or irradiation assisted stress relaxation; and (b) a methodology for estimation of ductility reduction of fracture toughness of reactor internals.

M15.0-4: *Recommendation*: Revise the program description to require applicants for SLR to ensure that the WCAP-17096 report (or this AMP) includes acceptable methodology for estimating reduction in fracture toughness and expressions for crack growth rates for reactor vessel internal materials such as SSs, nickel alloys, and low-alloy steels, including the potential effects of any relevant plant modifications since the original licensing basis.
***Technical Basis*:** The MRP-227 SER states that the guidance in WCAP-17096-NP, Rev. 2, will be used as the framework to develop those generic and plant-specific evaluations triggered by findings from the reactor vessel internals examinations. The NRC staff is currently reviewing the WCAP-17096-NP, Rev. 2, report. However, the WCAP report does not provide any detail for determining the reduction in fracture toughness of reactor vessel internal components, or for defining the allowable flaw size, and it does not describe the SCC, fatigue, or corrosion fatigue crack growth rates that would be needed to perform flaw tolerance evaluation and define adequate inspection intervals. The staff should ensure that the WCAP-17096 report (or this AMP) includes acceptable methodology for estimating reduction in fracture toughness and expressions for crack growth rates for reactor vessel internal materials such as SSs, nickel alloys, and low-alloy steels, including the potential effects of any relevant plant modifications since the original licensing basis....

M15.0-5: *Recommendation*: Revise the program description to include some guidance regarding the options proposed in RIS 2011-07.
***Technical Basis*:** Consistent with the recommendations of the GALL report, Ginna submitted for staff approval an AMP for reactor vessel internal components. However, with the issuance of MRP-227-A and consistent with the guidance of RIS 2011-07, Ginna stated that it will withdraw its reactor vessel internals program submitted for NRC review and approval, and resubmit a revised program within one year that will be consistent with the guidelines of WCAP-14577-1A and MRP-227-A. Several plants are likely to adopt this option. Therefore, the program description should be updated to include some guidance regarding the options proposed in RIS 2011-07.

1. <u>Scope of Program</u>:

M15.2-1: *Recommendation*: Revise the scope of program to include an evaluation of neutron fluence for specific reactor vessel internal components to identify specific aging degradation processes that need to be addressed and to establish acceptable methodology for estimating the reduction in fracture toughness and potential increase in crack growth rates for reactor internal components.
***Technical Basis*:** The scope of the program includes the response bases applicable to license renewal AAIs on the MRP-227 methodology. AAI #1 discusses the applicability of failure mode, effects, and criticality analysis (FMECA) and functional analysis assumptions, and AAI #3 discusses the adequacy of plant-specific existing programs. However, neither of these AAIs gives any detail on which specific issues/concerns need to be addressed in these assessments to verify the applicability of MRP-227 guidance, including plant-specific AMPs, to the applicant's facility. Since most of the aging degradation processes are related to neutron irradiation, it would be important include a TLAA or an engineering evaluation of the effects of neutron fluence for specific reactor vessel internal components, to define the threshold fluence for the susceptibility to degradation processes (e.g., IASCC, neutron embrittlement, void swelling, irradiation creep, or irradiation assisted stress relaxation). Such evaluations are used to establish acceptable crack growth rates or estimate reduction in ductility and fracture toughness for reactor vessel internals, which are needed to perform flaw growth and flaw tolerance analysis to determine adequate inspection intervals for reactor vessel internals.

M15.2-2: *Recommendation*: Revise the scope of program to include the requested information in its response to AAI #8.
***Technical Basis*:** Some plants disposition the fatigue CUF TLAAs for reactor vessel internal components using the 10 CFR 54.21(c)(1)(iii) option; instead of updating the analyses to include the PEO, they propose an inspection program such as that described in MRP-227-A to manage aging effects of fatigue damage. For such cases, this AMP should request that the applicant include the following in its response to AAI #8: (a) identify and verify accessibility of the fatigue sensitive location, (b) adequate inspection technique to detect fatigue cracks, and (c) a postulated flaw tolerance and growth analysis, including the effects of reactor coolant and neutron irradiation environment, to justify the adequacy of the inspection interval (consistent with MRP-227 SER Section 3.5.1, item 5).

M15.2-3: *Recommendation*: Revise relevant program elements of the AMP to include guidance for managing the effects of reduction in fracture toughness due to thermal and neutron embrittlement of CASS reactor vessel internal components.
***Technical Basis*:** License renewal AAI #7 asks the applicant to develop a plant-specific evaluation to demonstrate that the reactor internal components constructed of CASSs will maintain their functions during the PEO. These analyses consider the possible reduction in fracture toughness due to thermal and neutron embrittlement. As discussed M25.0-1 and M25.0-2, this AMP should either include relevant sections of GALL AMP XI.M13 or clarify that such a program is included in MRP-227 and that the Staff has reviewed it and found it to be consistent with GALL AMP XI.M13.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

M15.3-1: *Recommendation*: Revise the parameters monitored/inspection program element to include an assessment of degradation processes based on the total accumulated neutron dose for each component.
***Technical Basis*:** The program primarily monitors the effect of cracking on the intended function of the reactor internal components by detecting and sizing cracks through inspection. With continued operation, the total accumulated neutron dose continues to increase. Therefore, the total neutron dose at the end of the original 40-year period of operation would exceed the thresholds for IASCC, neutron embrittlement, and stress relaxation; some components are likely to exceed the thresholds for void swelling and irradiation creep during SLR. It would, therefore, be prudent to monitor the total dose of select sets of components to identify the potential for these various degradation processes in order to adequately define management activities needed to manage these aging effects.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M15.6-1: *Recommendation*: Revise the acceptance criteria to include validation of the 10-year inspection interval for highly irradiated components, and include the effects of plant modifications such as EPU.
***Technical Basis*:** This AMP basically follows the ASME Section XI 10-year inspection interval for all highly irradiated reactor vessel internal components. Recent data indicate that exposure to neutron irradiation to 5–8 dpa decreases the fracture toughness J_{Ic} value of SSs from well above 200 kJ/m^2 to as low as 7.5 kJ/m^2 (or K_{Jc} of 38 MPa m$^{1/2}$) (NUREG/CR-7027, Dec. 2010). In addition, the crack growth rates for moderate to highly irradiated wrought SSs and CASSs can be a factor of 20 higher than those for non-irradiated SSs. While the initial aging effect is a decrease in ductility and fracture toughness, unstable and increased rate of crack extension is the eventual aging effect if a crack is present and the local applied stress intensity exceeds the reduced fracture toughness. In view of significant reduction in fracture toughness and very high SCC and fatigue crack growth rates, it would be prudent to verify the adequacy of the 10-year inspection interval. Furthermore, the potential effect of plant modifications such as EPU on flaw tolerance analyses should also be evaluated.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M15.10-1: *Recommendation*: The OpE program element of this AMP may be updated to include the inspection results at Ginna. In addition, the use of plant-specific and industry-wide OpE for updating and implementing the program is considered a good practice or strength of the AMP.
***Technical Basis*:** At Ginna, the licensee stated that it considered baffle bolt OpE at DC Cook, Beznau (Switzerland),), and Surry and clevis pin insert screw experience from Cook, as well as its plant-specific OpE prior to implementation of its PWR Vessel Internals program. The Ginna reactor vessel internals inspections included significant interactions with a DOE program that is addressing long-term plant operation. The results of these inspections are provided in various reports and papers. In addition, adverse findings from the inspections are being documented through the MRP process and made available to the rest of the industry participants (all PWR licensees), and the inspection and evaluation guidelines being developed in MRP-227 will be modified accordingly. The use of plant-specific and industry-wide OpE for updating and implementing the program is considered a good practice or strength of the AMP.

Ginna discussed the following examinations (and background) related to baffle bolts:

- Because DC Cook found baffle bolt heads at the bottom of its reactor pressure vessel (lower core support plate), additional criteria were added at Ginna to visually examine the bolt head welds (locking device) as a first step.

- Surry OpE found ~1–2 UT indications out of 1080 bolts inspected.

- Beznau (Switzerland) found unsatisfactory UT results in 2009.

- In 1999, Ginna replaced 56 out of 728 bolts. Although 14 were identified as having cracks, laboratory examination identified only 1 bolt with a crack, indicating that the UT method employed at that time was conservative.

- Ginna's target was to demonstrate that a minimum bolting pattern of 121 bolts plus a 50% margin of safety would justify operation for 10 years, with an assumption that 50% of the 728 bolts failed.

4.2.16 Flow-Accelerated Corrosion (XI.M17)

4.2.16.1 Objective and Scope of Rev. 2 AMP XI.M17

The objective of this AMP is to manage the aging effect of wall-thinning due to the FAC of components made of CSs as well as low-alloy steels, especially with low chromium content, in systems with single-phase (water) as well as two-phase (wet steam) flow. The aging mechanism of FAC refers to the result of interaction between the flow characteristics and the corrosion product influenced by the material composition and water chemistry. Any reference to the erosion (in erosion-corrosion) in the context of FAC is limited to the action of (non-impacting or non-abrasive) mechanical removal of material from the corrosion product (usually some form of an oxide film or layer) itself, and not directly from the base metal or original alloy material (underneath the corrosion product). That is, this AMP does not address wall loss due to cavitation, impingement wear, or other similar mechanical effects. Therefore, either this program should be enhanced or a new AMP developed to address the management of these aging effects.

The scope of this AMP covers piping elements, piping components, pressure boundary nozzles, safe-ends, vessel/shell walls, and some structural elements, of both safety-related and non-safety-related systems within the primary pressure boundary as well as the balance-of-plant where FAC has been observed or is expected to occur.

To ensure that the wall-thinning effect due to FAC of components in scope of this AMP will be adequately managed such that their intended functional integrity is maintained during the extended and LTO, the AMP relies on several AMAs, which include (i) identification and prioritization of FAC-prone components/locations; (ii) qualified periodic inspections for wall-thinning and measurements of wall thickness at select locations; (iii) data trending for technically justified, conservative determination of wall loss and wall-thinning rate; (iv) calibration or re-baselining of predictive model for FAC-significant changes in system layout, operating (flow or chemistry) conditions, or observed thinning rates; (v) determination of safe interval for next inspection and dispositioning based on validated/approved acceptance criteria; and (vi) mitigation, repair, or replacement for corrective action and LTO.

For these AMAs, the AMP relies on the requirements or guidance from the following:
(i) EPRI NSAC-202L-R2 or R3 for the program implementation, detection and mitigation of FAC;
(ii) CHECWORKS or similar FAC prediction/assessment tool;
(iii) engineering judgment aided by the OpE and the EPRI report “Flow-Accelerated Corrosion in Power Plants,” TR-106611-R1 (1998); and
(iv) technically justified/approved acceptance criteria.

4.2.16.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.15, “Flow-Accelerated Corrosion” and NMP-1 through its AMP B2.1.9, “Flow-Accelerated Corrosion Program.” The AMPs at Ginna and NMP-1 are based on Revision 0 of the GALL Report, and both LRAs state that the respective AMPs are consistent with AMP XI.M17 of the GALL Report, “Flow-Accelerated Corrosion,” with no exceptions or enhancements. Both LRAs note that their AMPs are in accordance with EPRI guidelines in the Nuclear Safety Analysis Center (NSAC) NSAC-202L, Rev. 2, and both utilize the CHECWORKS predictive code.

During the Ginna audit, the site personnel noted that the PBD was revised showing that the service water piping and the fire protection piping were removed from its flow-accelerated

corrosion (FAC) program scope and the CHECWORKS model was converted and updated to SFA Version 2.1. The staff found that Ginna's most recent program health report provided an excellent picture of the program's implementation and the status of current issues, and that the program appeared to address other wall thinning mechanisms like cavitation, even though these mechanisms do not meet the definition of flow-accelerated corrosion. (Subsequent to the audits at Ginna and NMP-1, NRC staff issued a draft license renewal Interim Staff Guidance (LR-ISG) to expand the scope of GALL AMP XI.M17 to also address cavitation and other erosion phenomena.) In addition, the staff noted that the site upgraded to NSAC-202L, Rev. 3, which is consistent with the GALL Report, Rev. 2.

During the NMP-1 audit, the site's most recent program health report (third quarter 2011) provided a comprehensive picture of the program's implementation and related issues. The staff noted that the FAC program inspection scope did not need to be expanded during the last outage from the initial plan and that the FAC-related repairs or replacements had been anticipated based on prior inspection results. From an OpE perspective, the program health report also maintained a list of relatively recent plant-specific and industry issues along with the disposition for each item. This provided documentation that operating experience was being considered and evaluated as part of the AMP at NMP-1.

4.2.16.3 Effectiveness of AMP XI.M17 to Meet Its Objective

Audit reports from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.17, "AMP Worksheet XI.M17 Flow-Accelerated Corrosion." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.16.4.

4.2.16.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not clearly define the aging degradation addressed by this AMP and exclude certain types of wall-thinning mechanisms often mixed or associated with the FAC. In addition, the materials, components, and systems to be managed for FAC are not clear from the description.

(b) The description does not adequately clarify the need for independence and implementation of three separate but key elements of the program: procedural guidance, predictive tools for assessment, and relevant acceptance criteria. It does not clarify that the corrosion allowance in original design, as per the design codes, does not address FAC and that the leak-before-break concept is generally not applicable to the FAC degradation.

(c) From the current description it is not clear that the program relies on a limited set of inspections, making their prioritization a critical element that needs to reflect considerable engineering judgment for plant-specific conditions, and that there is only one aging effect of FAC, namely, the associated wall-thinning, addressed in this AMP.

(d) The program description lacks guidance or basis documents on the relevant acceptance criteria needed in assessing aging effects due to FAC for reasonable assurance of its management.

4.2.16.3.2 Effectiveness and Implementation of AMP XI.M17

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," does not clarify or well characterize the extent of scope of this AMP with regard to the materials, components, and systems requiring FAC management, and does not include elements of long-term strategy as part of the scope.

(b) Program Element 2, "Preventive Actions," does not adequately emphasize the need for mitigative measures for LTOs, clarifying any limitations or dependence of mitigation options depending on the single-phase versus two-phase flow conditions.

(c) Program Element 3, "Parameters Monitored/Inspected," limits the activity to only the measurement of wall thickness (under active list of inspections). It does not address the need for monitoring those parameters needed for predictive assessment or confirmation of basis for any exclusion list, and for effects of any design modification or replacements resulting in a change of material or flow characteristics.

(d) Program Element 5, "Monitoring and Trending," notes that "CHECWORKS is acceptable because it provides a bounding analysis for FAC" and that "CHECWORKS is not always conservative when compared to actual field measurements." In addition, the program element (i.e., trending whose intended purpose is to provide a projection basis going forward) does not adequately clarify (or specify) the required conservatism and bounding on the estimation of wall-thinning rate.

(e) Program Element 6, "Acceptance Criteria," does not provide or clarify the required acceptance criteria and/or basis document(s) for these, nor does it reflect that the acceptance criteria are independent of, and in addition to, the predictive method or the inspection results used as input to the predictive method. Guidance on more specific and well-qualified acceptance criteria needs to be developed, confirmed (validated), and included in the AMP.

In addition, the program element does not adequately describe or clarify the need for acceptance criteria to address seismic loads, the ISI and IST under 10 CFR 50.55a(q), or the 10 CFR 50 Appendix B requirements that the acceptance criteria be verified with independent testing and/or theory and analysis.

(f) Program Element 10, "Operating Experience," does not adequately reflect or clarify the need for a self-assessment and a critical review of plant-specific program if its OpE does not meet performance goals from its long-term strategy, or to confirm the expectation from

incorporation of improved methods and industry experience over a long period in the FAC management that the frequency and severity of FAC incidence is trending lower with time.

The AMPs implemented by both Ginna and NMP-1, which are based on Rev. 0 of the GALL Report (2001), and by most of the license renewal applicants in general, have been consistent with the GALL AMP XI.M1. Therefore there have been no industry proposed exceptions or enhancements to this AMP.

No specific good practices or strengths of the AMP were identified in this review.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.16.4 Recommendations for Subsequent License Renewal

4.2.16.4.1 Good Practices or Strengths of AMP XI.M17

No specific good practice was identified during the review.

4.2.16.4.2 Areas of AMP XI.M17 for Further Consideration/Enhancement

Program Description:

M16.0-1: *Recommendation*: Clarify the definition and intended usage of the term FAC for the aging degradation of wall-thinning addressed by this AMP, and exclude from the scope certain types of wall-thinning mechanisms often mixed or associated with the FAC. Include the materials, components, and systems to be managed for FAC under the scope of this AMP.
***Technical Basis*:** The term “wall-thinning” and, in some cases, “FAC” have been incorrectly identified with wall loss in general and/or wall loss resulting from other types of degradation (e.g., erosion-corrosion, cavitation, and impingement wear). In addition, the management of FAC itself is significantly different between single-phase and two-phase flow systems, although both are addressed in this AMP, and the materials affected by FAC include general CSs as well as low-alloy steels, especially with low chromium content (where the chromium threshold is also dependent on single-phase versus two-phase flow).

M16.0-2: *Recommendation*: State the need for independence and implementation of three separate but key elements for effectiveness of this AMP: the procedural guidance, the predictive tools for assessment, and the relevant acceptance criteria. Also note that for added significance of this AMP, the corrosion allowance in original design, as per the design codes, does not address FAC and that the leak-before-break concept is generally not applicable to the FAC degradation.
***Technical Basis*:** The stated objective of the current basis document, NSAC-202L-R3, is, “To present a set of recommendations for NPPs for implementing an effective program to detect and mitigate FAC,” with no specific consideration for the term of operation. While the NSAC-202L-R2 or R3 provides a general guidance for acceptable procedural and implementation guidelines for the organization, activities, and typical elements of an effective FAC program, the aging management for long-term program requires two additional and independent aspects: (1) a predictive tool or model (e.g., CHECWORKS or similar) to estimate the future wall-thinning rate and expected minimum wall prior to next inspection, with benchmarking and conservatism to address prediction uncertainty; and (2) valid/approved acceptance criteria. It is also important to note that the original design methodology does not address or account for wall loss due to

FAC that, if for any reason undetected over a long period, has the potential to lead to sudden and unexpected component failure and loss of functionality, and that the leak-before-break concept is generally not expected to apply for such degradation.

M16.0-3: *Recommendation*: Clarify that the reliance of this program on a limited set of inspections whose prioritization is a critical element requiring considerable engineering judgment for plant-specific conditions, and that there is only one aging effect of FAC, namely, the associated wall thinning addressed in this AMP.
***Technical Basis*:** In item (a) of the current description, it is not clear what (or how) analysis is to be performed to determine critical locations, and in item (b), it is not apparent why only limited baseline inspections would be adequate to manage the aging effect over LTO. In addition, in the current description the reference to "all aging effects" being properly managed seems vague, particularly when only wall-thinning is addressed in the NSAC report and the CHECWORKS program. The limitation and supporting basis for adequacy of select inspections under this AMP, especially when some locations are likely to remain uninspected when considering the PEO, need to be clearly stated as part of the program description.

M16.0-4: *Recommendation*: Provide some guidance and/or basis documents on relevant acceptance criteria needed to assess the aging effects due to FAC for reasonable assurance of its management.
***Technical Basis*:** The current program description and referenced basis document lack guidance on the acceptance criteria needed to assess and disposition the findings of wall thinning due to FAC for reasonable assurance of its management.

1. <u>Scope of Program</u>:

M16.1-1: *Recommendation*: Include in the scope description the type of materials and components most likely to experience FAC degradation to be managed by this AMP, and elements/focus of the program to incorporate a long-term strategy beyond the inspections.
***Technical Basis*:** The program element description should clarify or well characterize the extent of this AMP; at minimum, the scope should include general CSs and low-alloy steels, especially those with low chromium content, as materials, and piping elements, piping components, pressure boundary nozzles, safe-ends, vessel/shell walls, and some structural elements as components subject to FAC.

NSAC-202L-R2 or R3 incorporates "Long-term Strategy" as an essential part of a plant FAC program scope. In addition, for the PEO, the AMP should expand on and address the key aspect(s) of this strategy that are important elements to be integrated and assessed in the scope of this program. According to the EPRI guideline strategy the FAC program should focus on reducing FAC wear rates, without which the number of needed inspections will increase with service time; even with selective repair and replacement, the likelihood of a consequential leak or rupture may increase with service time.

2. <u>Preventive Action</u>:

M16.2-1: *Recommendation*: Emphasize the role of mitigative measures for the LTOs and clarify limitations of the noted mitigation options as dependent on the single-phase versus two-phase flow conditions.
***Technical Basis*:** Effectiveness of chemistry control and material selection for FAC mitigation as noted in the program element description is significantly dependent on whether the FAC is under single-phase flow or two-phase flow. In addition, one of the program objectives is to

prevent failure of a component as a result of the wall thinning due to FAC; however, since the approach is based on inspection of a prioritized and limited sample of susceptible locations, it needs to be noted that preventing all FAC-related leaks and ruptures may not be possible. Therefore, the significance of aggressively adopting mitigative measures in the AMP needs emphasis for the program to be effective over a PEO.

3. <u>Parameters Monitored/Inspected</u>:

M16.3-1: *Recommendation*: Expand the scope of activity under this program element to include parameters needed for any predictive method implemented as part of this AMP, and monitoring (or confirmation) of those factors used in justifying any exclusions from the FAC component listing.
***Technical Basis*:** The predictive modeling tools, such as CHECWORKS, and related prioritized ranking for inspections under this program often depend on, or make use of, several parameters other than wall thickness. In addition, exclusions are made on the basis of certain factors that may be affected by operational changes or by any design modification or replacement decisions that result in a change of material or flow characteristics. These should be monitored and/or confirmed in an appropriate time interval.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

M16.5-1: *Recommendation*: Revise to clarify or reconcile the apparent contradiction in stating that "CHECWORKS is acceptable because it provides a bounding analysis for FAC" and that "CHECWORKS is not always conservative when compared to actual field measurements." Recommend that the projection for wall thinning be based on a bounding estimate of the FAC rate allowing for uncertainty. Recommend an engineering evaluation and appropriate program adjustments for cases where the condition monitoring did not meet the expected (bounding) performance, and to document reasons or inadequacies (programmatic, operational, modeling, model inputs, etc.) for recalibration of projection basis.
***Technical Basis*:** For projection basis, it is the incremental wall-thinning (i.e., estimation of the FAC rate going forward) that is a determining factor so that its value and associated uncertainty in this estimation need to be conservatively bounded and subsequently confirmed, rather than to impose any correction to the basis after the fact. That is, any benchmarking and use of bounding values should be based on a comparison of the predictions against conservative estimates of the observed wall-thinning rates. In addition, for those components deemed not to require immediate repair or replacement, the inspection frequency is to be such that the repair or replacement occurs prior to reaching the wall thickness criteria. It implies that the condition monitoring aspect of the program is not met if the observed wall thickness during any inspection is below the allowable limit, in which case an engineering evaluation and self-assessment of the of monitoring and trending elements of the FAC program needs to be performed and adjustments made such that the OpE is demonstrably bounded, and the root cause of failure to meet the expected performance has been identified and addressed in the program.

6. <u>Acceptance Criteria</u>:

M16.6-1: *Recommendation*: Review and include the needed guidance for acceptance criteria, independent of any predictive method, that are more specific to the expected failure mode(s),

well qualified with a technical basis, confirmed (validated).
***Technical Basis*:** The acceptance criteria are needed to disposition the as-observed wall-thinning or the as-predicted minimum wall at the end of next inspection interval. This disposition about repair, replacement, and inspection interval is based on criteria independent of the NSAC-202L R2 or R3 and the prediction model (e.g., CHECWORKS), and need to address (conservatively account for) applicable mode(s) of failure. CHECWORKS does not provide assurance for meeting ASME acceptance criteria (for allowable minimum wall); as these functions are outside the scope of CHECWORKS. ASME Code Case 597-2 provides requirements applicable to nonplanar flaws of the type resulting from FAC; these requirements are for Classes 1, 2, and 3 piping elements (as given in Section 3220 of the Code Case) are in addition to the acceptance standards of the Construction Code of record. This Code Case has received conditional acceptance by the NRC (i.e., alternative requirements must be supplemented in order to provide an acceptable level of quality and safety). The Code Case itself indicates in Section 3223 that the acceptance by engineering evaluation for Class 1 piping shall be conducted with methods and criteria developed by the Owner. The supplemental requirement for Class 1 piping that does not meet the criteria by inspection is that evaluation methods and criteria are subject to NRC review and approval per 10 CFR 50.55a(a)(3). In addition, in Section 3500(5)(b), the Code Case indicates that the acceptance criteria for Class 1, 2, and 3 pumps, valves, flanges, reducing elbows, socket and weld fittings, and any other piping items not covered by Section 3500(a) are the responsibility of the Owner.

M16.6-2: *Recommendation*: Review and include the needed guidance for acceptance criteria, independent of any predictive method, to be used to meet the applicable requirements (listed below).
***Technical Basis*:** The FAC relevant safety-related portions of various reactor coolant and balance-of-plant systems are required to meet seismic criteria, design quality assurance of 10 CFR 50 Appendix B, as well as ISI and IST under 10 CFR 50.55a(q), ASME Code Section XI, and the applicable Codes and standards for the original design and fabrication. The quality assurance of 10 CFR 50 Appendix B requires that the acceptance criteria be verified with independent testing and/or theory and analysis. In addition, if the seismic criteria or inputs to the seismic analysis are updated or if the transient definitions change during the PEO, then the basis for estimating allowable minimum wall thickness is likely to be affected; the acceptance criteria for FAC AMP should reflect this possibility.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M16.10-1: *Recommendation*: Revise this element to (a) include self-assessment and a critical review of plant-specific programs to identify and correct the reasons long-term strategy is not meeting performance goals from the OpE, and (b) confirm the expectation that the frequency

and severity of FAC incidence is trending lower with time.

***Technical Basis*:** Based on some of the plant-specific histories, including any chronological list of condition reports, there appear to be several instances of rejectable FAC indications, UT thickness readings below design basis or min-wall, excessive thinning, and non-conforming conditions for FAC.

For a mature industry-wide condition-monitoring program, it is unclear whether such continued instances reflect systemic under prediction in the methodology or an uncaptured increase in FAC susceptibility (or both). The expectation from incorporation of improved methods and industry experience over a long period in the FAC management is that frequency and severity of FAC incidence will be reduced with time. This should be confirmed at the individual plant level through the program self-assessment.

4.2.17 Bolting Integrity (XI.M18)

4.2.17.1 Objective and Scope of Rev. 2 AMP XI.M18

The objective of this program is to manage the aging-related degradation of closure bolting for pressure retaining components of safety-related as well as non-safety related systems, separately from the structural bolting. The aging effects managed by this program include loss of preload, loss of material (due to wear or corrosion), and cracking of the bolting.

The closure bolting addressed by this AMP includes components of the RCS, the RCPB and reactor internals. In addition, this AMP is also credited to manage the aging-related degradation of bolting in the engineered safety feature systems, the auxiliary systems, and the steam and power conversion systems. However, the reactor closure head stud bolting is managed under GALL AMP XI.M3. In addition, all structural bolting is addressed in other GALL AMPs: XI.S1, "ASME Section XI, Subsection IWE"; XI.S3, "ASME Section XI, Subsection IWF"; XI.S6, "Structures Monitoring"; XI.S7, "RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants"; and XI.M23, "Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems." The GALL AMP XI.M1, ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD, which includes inspection of safety-related and non-safety-related closure bolting, supplements but does not replace or substitute for this bolting integrity program.

To ensure that the various aging effects due to corrosion, wear, and loading of the bolting in scope of this AMP will be adequately managed such that their intended functional integrity is maintained during the extended and LTO, the AMP relies on several AMAs, which include: (i) periodic inspections of the bolting for loss of preload, loss of material, and cracking; (ii) preventive actions to preclude or minimize the loss of preload and cracking; (iii) maintenance including the related requisite training and qualification of personnel involved; (iv) monitoring for leakage in safety-related bolting, for signs of leakage in other bolting, and for cracking in high-strength closure bolting; and (v) condition assessment with any required corrective action of repair or replacement.

For these AMAs, the AMP relies on the requirements or guidance from the following documents:
(i) NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*;
(ii) EPRI 1015336, *Nuclear Maintenance Applications Center: Bolted Joint Fundamentals*; and
(iii) EPRI 1015337, *Nuclear Maintenance Applications Center: Assembling Gasketed, Flanged Bolted Joints*.

4.2.17.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.5, "Bolting Integrity," and NMP-1 through its AMP B2.1.36, "Bolting Integrity Program," both of which are based on the GALL Report, Rev. 0.

The Ginna audit confirmed that its Bolting Integrity program, although cited as a separate program, does not implement any activities itself, but instead credits activities performed under several other AMPs for managing specific aging effects associated with bolting. During the Ginna audit, the staff noted that the applicant's PBD identified that one of these credited AMPs, namely, its Structures Monitoring program, was not consistent with the GALL Report AMP in that additional tests for detecting degradation of structural bolting and fasteners, such as hammer tests, in-situ ultrasonic tests or proof tests by tension or torqueing were not planned

unless specifically required as a result of a potentially degraded condition. The implementation of this Ginna AMP was not evaluated because all inspection activities are conducted through the implementation of other AMPs. The Ginna audit found no condition reports specifically connected with its Bolting Integrity program, so no corrective actions could be evaluated relative to this program. Also, the Ginna operating experience review reports consistently stated that either no inspections were performed or no conditions were noted. During the Ginna audit, it was noted that the PBD was revised in April 2009.

The NMP-1 auditor noted that NRC inspectors reviewed the commitments associated with this program, during its IP 71003, "Post-Approval Site Inspection for License Renewal," and concluded that the licensee had enhanced the Bolting Integrity, Structures Monitoring, and System Walkdown Programs as stipulated in Commitment No. 33 (NRC Inspection Report 05000220/2009007). The NMP-1 audit also noted that, although the program was not included in any recent program health report, the licensee's recent self-assessment concluded that there were no issues with the AMP. This report also stated that the licensee had identified and inspected all high-strength bolting and had included any condition monitoring requirements for the remaining bolting in the Structures Monitoring and Systems Walkdown inspection checklists.

4.2.17.3 Effectiveness of AMP XI.M18 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.18, "AMP Worksheet XI.M18 Bolting Integrity." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.17.4.

4.2.17.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not clarify or limit the role of other GALL AMPs that can lead to de-emphasizing certain AMAs specific to the bolting integrity program.

(b) The program description does not provide and adequately emphasize the need for following the revised and updated guidance (basis documents).

4.2.17.3.2 Effectiveness and Implementation of AMP XI.M18

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, “Scope of Program,” does not clarify or include the scope delineation in the plant-specific program based on the requisite bolting classification (i.e., whether safety related or non-safety related, in the ASME Section XI scope or outside of its scope, and high-strength or not).

(b) Program Element 2, “Preventive Actions,” includes multiple guidelines without providing more definitive guidance on the level and monitoring for preload requirements.

(c) Program Element 4, “Detection of Aging Effects,” does not adequately emphasize the need to identify all in-scope high-strength bolting based on the actual yield strength, nor does it provide guidance for cases in which such identification is not possible or implemented.

(d) Program Element 10, “Operating Experience,” does not note or adequately reflect the OpE results showing (a) that the overall effectiveness of this AMP is quite plant-specific and is considerably impacted by the personnel training (qualification) and maintenance practices followed, and (b) the need for program implementation procedures to affirm the use of good mechanical maintenance/work practices as recommended in the industry/regulatory guidelines, in addition to the periodic self-assessment of the AMP results.

The bolting integrity AMP at Ginna is based on Rev. 0 of the GALL Report (2001); neither the LRA nor the related SER (for Ginna) cited any exceptions with the GALL AMP, nor did they include any enhancements or commitments associated with this AMP. However, it was noted that the Ginna program basis document identified that the related Structures Monitoring Program was not consistent with the GALL AMP, in that additional tests for detecting degradation of structural bolting and fasteners were not planned unless specifically required as a result of a potentially degraded condition. The SER did not discuss or identify any issues relating to this inconsistency. As noted for Ginna, with similar adoptions likely at a few other plants, the program implementation has allowed for the Bolting Integrity AMP to exclude any activities by itself, instead crediting activities performed under other AMPs for managing specific aging effects associated with bolting. The NMP-1 AMP is also based on Rev. 0 of the GALL Report (2001) and, as noted in the LRA and associated SER, is consistent with an exception and enhancements, stated in Commitment #33 in Appendix A of the LRA for NMP-1.

Several applicants in the past have used other (EPRI) documents as the AMP basis instead of the GALL Report basis documents. This adds to the uncertainty about consistency and effectiveness of program implementation. If basis documents, especially as revised by the industry and the regulatory body, are substituted then consistency with GALL, uniformity of implementation, and confirming effectiveness of the AMP require additional and unnecessary effort.

This review of plant implementation did not identify any specific good practices or strengths of the AMP.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.17.4 Recommendations for Subsequent License Renewal

4.2.17.4.1 Good Practices or Strengths of AMP XI.M18

No specific good practice was identified during the review.

4.2.17.4.2 Areas of AMP XI.M18 for Further Consideration/Enhancement

Program Description:

M17.0-1: *Recommendation*: Clarify the role of other GALL AMPs noting the need for activities to be followed as part of this AMP. That is, the only other GALL AMP recommended to supplement the bolting integrity AMP is XI.M1, ASME Section XI ISI, Subsections IWB, IWC, and IWD, which addresses only the periodic inspection activity of this AMP. The other recommended activities of preventive action, monitoring, training, and maintenance, specific to the bolting, are part of this AMP.
***Technical Basis*:** The GALL AMP XI.M1, ASME Section XI ISI, Subsections IWB, IWC, and IWD, which includes inspection of safety-related and non-safety-related closure bolting as part of its condition monitoring, does not specifically address or adequately emphasize the other integral activities recommended for the effective management of bolting related degradation effects. Its intended role is limited to supplementing this bolting integrity program.

M17.0-2: *Recommendation*: Confirm and replace the EPRI basis documents with the latest, consolidated guidance from EPRI, strongly recommending adherence to the uniform basis. Use of basis documents and/or AMPs not listed in the GALL bolting integrity AMP description will be an exception to XI.M18 requiring that the LRA clearly identify which basis documents are used under which credited AMPs and how these alternatives meet the bolting integrity program activities.
***Technical Basis*:** Several applicants in the past have used other (EPRI) documents as the AMP basis instead of the GALL Report basis documents. This adds to the uncertainty about consistency and effectiveness of program implementation, especially if the documents used are much older (e.g., EPRI NP-5067) than the recommended basis. In addition, the industry-recommended guidance has changed as bolting practices and experience, have evolved, so the various basis documents listed have remnant contradictions [as indicated in a study by EPRI's Nuclear Maintenance Applications Center (NMAC)]. The EPRI NMAC study has reconciled and consolidated the various earlier EPRI/industry guideline documents into two EPRI reports (1015336 and 1015337). That is, the oldest two-volume EPRI NP-5067 report has been removed from normal access (archived only for reference) and the EPRI TR-104213 has been replaced with the new guidance documents. If basis documents, especially as revised by the industry and the regulatory body, are substituted then consistency with GALL, uniformity of implementation, and confirming effectiveness of the AMP require additional and unnecessary effort.

1. Scope of Program:

M17.1-1: *Recommendation*: The LRA should include a delineation in the plant-specific program indicating (tabulating) (a) the bolting classification for all in-scope bolting covered under this AMP (i.e., whether safety related or non-safety related, and whether in the ASME Section XI scope or outside of its scope, and whether high-strength or not), and (b) which other AMPs are being credited to manage the aging effects of the so-classified bolting components.
***Technical Basis*:** The aging management actions under other program elements and the applicable basis documents of this AMP are dependent on the clarity (transparency) of this classification, without which the implementation and effectiveness of this AMP cannot be fully assessed.

2. <u>Preventive Action</u>:

M17.2-1: *Recommendation*: Limit the guidance on preventive actions to those specified in the recommended, as-updated, basis documents listed in the XI.M18 program description. Review and include more specific guidance on the level and monitoring for preload.
***Technical Basis*:** Specifying the use of multiple guidelines for preload likely results in non-uniformity and conflicting requirements. In addition, determination of actual preload and its monitoring have been problematic and often substituted to be managed by torqueing. Better and more definitive guidance with regard to the preload requirements (its level and monitoring) is significant to the aging effect management of bolting in LTO.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M17.4-1: *Recommendation*: The AMP should include identification of all in-scope high-strength bolting based on the actual yield strength; the AMP should provide guidance for those cases where this identification is not possible or implemented.
***Technical Basis*:** While the most recent (Rev. 2) GALL Report adds a statement clarifying the volumetric examination requirement for all high-strength closure bolting, this requirement was unclear in previous versions of the GALL Report used as a basis in most existing plants. Furthermore, program implementation cannot be as effective unless the high-strength bolting has been fully identified (based on the actual yield strength); often, where such identification has not been rigorously performed, redundancy or other reasons are given, leading to potentially inadequate examinations as needed. Degradation of the high-strength closure bolting, particularly due to SCC that can remain undetected or may not necessarily lead to identifiable leaks in a timely manner, over longer terms of operation has the potential to contribute to the loss of functionality. In addition, if a particularly susceptible heat of material was used in multiple bolting items whose high-strength attributes remained unidentified, then multiple failures are likely to occur and reduce any effectiveness of the redundancy argument.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M17.10-1: *Recommendation*: For this maintenance-driven and inspection-based program, include as part of the AMP guidance a periodic review confirming the reduction of bolting related events and, depending on the review findings, recommend appropriate corrections or adjustments to the program, through better training, tools, or practices.
***Technical Basis*:** The OpE on bolting-related activity shows that the overall effectiveness of this AMP is quite plant-specific and is considerably impacted by personnel training (qualification) and maintenance practices followed. Repeat instances of bolting-related reports or corrective actions are also indicative of a need for improvements and self-assessment of plant-specific implementation of this AMP. While these may not directly reflect on any aging effect, per se, the continued instances reflect on the quality and adequacy of the bolting procedures or implementation, since, for the program to be demonstrably effective over time, the evolution of the frequency and number of locations of identified leakages (at the bolting interfaces) should not be growing.

M17.10-1: *Recommendation*: Clarify and note that the OpE suggests the need for procedurally ensuring (a) the use of good mechanical maintenance practices, and (b) review and implementation of good work practices as recommended in the AMP basis documents, in addition to periodic self-assessment of the AMP results.
***Technical Basis*:** A recent (October 2011) Supplemental Inspection 05000455/2011016 was performed by the Staff to examine the causes for, and actions taken related to, a finding having low to moderate safety significance at Byron Station, Unit 2. The finding (from NRC Inspection Report 05000455/2011011) involved the failure to ensure that a flange connection on the upper lube oil cooler of the 2A emergency diesel generator (EDG) was correctly torqued following maintenance, leading to shutdown of the 2A EDG when a significant oil leak developed (during routine monthly surveillance testing).
This recent supplemental inspection also revealed an adverse trend in maintenance rework issues centered on poor mechanical maintenance practices, including several examples resulting in bolted connection leakage. The root cause was that there was no formal structured process in place to ensure that EPRI bolting guidance documents were actually reviewed to capture good work practices. Inadequate procedural direction on the assembly of multiple joint configurations was noted as the contributing cause.

4.2.18 Steam Generators (XI.M19)

4.2.18.1 Objective and Scope of Rev. 2 AMP XI.M19

The objective of this SG program is to manage the aging of SG tubes, plugs, sleeves, and secondary side components (SG internals) for the functioning of SGs as required under the applicable technical specifications. This AMP manages various forms of aging-related degradation on the primary and secondary sides of the SGs. Thus, in addition to the PWSCC of SG tubes, sleeves, and plugs, the AMP manages wall-thinning of tube-support structures susceptible to FAC and general corrosion (in the secondary side of SGs), cracking due to stress corrosion or other mechanisms and loss of material due to fretting or corrosion of various supports (secondary side internals), tube denting due to corrosion of CS support plates at tube intersections, cracking due to SCC/intergranular attack (IGA) and loss of material from fretting/wear of tubes and sleeves (from the secondary side).

To ensure that the various aging effects due to corrosion and wear of SG tubes and internals in scope of this AMP will be adequately managed such that their intended functional integrity is maintained during the extended and LTO, the AMP relies on an integration of prevention, mitigation, inspection, evaluation, repair, and leakage monitoring measures. Thus, the AMP relies on six AMAs: (i) periodic degradation assessment of SGs, (ii) condition monitoring and operational assessment of SGs, including structural and leakage integrity of tubes to meet specific performance criteria, (iii) qualified periodic examinations/inspections for the listed (expected) forms of degradation, (iv) dispositioning of all flaws/indications with technically justified acceptance criteria for each form of degradation, (v) acceptable methods of tube plugging and repairs, and (vi) online leakage monitoring. This AMP also relies on monitoring and maintenance of primary and secondary water chemistry as described in GALL AMP XI.M2.

For these AMAs, the AMP relies on the requirements or guidance from the following documents:
(i) Standard SG technical specification (NUREG-1431/1432/1433, Vol.1, Rev. 3);
(ii) Plant-specific technical specification for the SG;
(iii) NEI 97-06 (current revision: Rev. 3, January 2011), *Steam Generator Program Guidelines*; and
(iv) Current EPRI/Industry guideline documents (incorporated by reference in NEI 97-06, which include the latest approved Steam Generator Management Program (SGMP): PWR Steam Generator Examination Guidelines, PWR Primary-to-Secondary Leak Guidelines, PWR Primary Water Chemistry Guidelines, PWR Secondary Water Chemistry Guidelines, Steam Generator Integrity Assessment Guidelines, and Steam Generator In Situ Pressure Test Guidelines.

4.2.18.2 Observations from Ginna

This AMP is not applicable to NMP-1 because it is a BWR. The Ginna LRA states that Ginna implemented this program through its AMP B2.1.31, “Steam Generator Tube Integrity,” which is based on the guidance documents NEI 97-06 and EPRI TR-107569. The Ginna AMP is consistent with AMP XI.M19 of the GALL Report, “Steam Generator Tube Integrity,” as described in the SER for Ginna license renewal.

In view of the recent industry OpE on the PWSCC of nickel-based alloys in the steam generator (SG) divider plate assemblies and tube-to-tubesheet welds, the staff requested the licensee to provide information regarding its actions in addressing the aging management of these SG components. In its review, the staff noted that the licensee uses PWSCC-resistant Alloy 690 tubing with the tube sheet cladding made of Alloy 82. A potential concern is that the

autogenous welds of the tubes with Alloy 82 cladding may cause dilution effects on material composition so that the resistance of the welds to PWSCC may be decreased.

It was also noted that qualified eddy current techniques for the tube-to-tubesheet welds have not been developed yet. In addition, Ginna indicated that it performed 100 percent visual inspections of the divider plate weld areas during the last two SG inspections (2008 and 2011), with no detectable degradation.

During the Ginna audit, the staff also noted that the licensee's Technical Specifications (TS) require maintaining a SG Tube Integrity program that is consistent with the industry guidance NEI 97-06, which is the basis for the SG AMP. The staff further noted that the Ginna AMP is based on the latest industry examination guidelines (EPRI 1013706, *PWR Steam Generator Examination Guidelines: Revision 7).*

As part of the audit of the SG AMP implementation at Ginna, the staff reviewed the licensee's performance concerning the potential for degradation due to foreign objects and noted that the GALL Report, Rev. 2, addresses FME. The licensee indicated that it has implemented a Foreign Object Search and Removal (FOSAR) Program in SG vendor procedures and that its OpE indicates foreign object exclusion to be a potential concern related to the material degradation in SG components.

In addition, the staff noted that the licensee's program health report and report on "license renewal related condition report trends" periodically assess the OpE related to the Steam Generator Tube Integrity program and associated components.

4.2.18.3 Effectiveness of AMP XI.M19 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.4.19, "AMP Worksheet XI.M19 Steam Generators." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.18.4.

4.2.18.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not clarify or confirm which aging effects are managed under this AMP (and which are not covered but may be relevant: e.g., cracking due to metal fatigue).

(b) The program description does not clarify or adequately emphasize the need for timely updating the AMP implementation in accordance with the basis documents and related requirements, which continue to undergo frequent revisions important for ensuring their effectiveness to manage the SG degradation.

4.2.18.3.2 Effectiveness and Implementation of AMP XI.M19

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," does not adequately reflect the importance of tube support structures, although these may be viewed as part of secondary side internals. In addition, the scope does not address other SG internals (on the primary side) – including the nickel-based (cladded) divider plate/tubesheet, associated welds/HAZ, and welded tube-ends – that have shown susceptibility to PWSCC.

(b) Program Element 2, "Preventive Actions," does include a foreign material exclusion program action item; however, its focus is on the secondary side, with less clarity regarding similar action on the primary side. In addition, the actions do not include, or provide guidance for, any formal (engineering) evaluation of foreign objects to prevent further (continued) degradation and to allow for its timely management.

(c) Program Element 3, "Parameters Monitored/Inspected," does refer to other water chemistry programs (GALL AMP XI.M2) for monitoring; however, the importance of off-normal chemistry parameters to be monitored and assessed periodically is not clear with specific reference to the needs of AMP XI.M19. In addition, the reference to fatigue of tubes, not covered elsewhere in this AMP, is unlikely to be limited to only mill-annealed Alloy 600 (as noted), and needs further clarification and/or guidance on the issue.

(d) Program Element 4, "Detection of Aging Effects," does not include (clarify) or address effective means of detection of degradation in the (cladded) tubesheet, divide plate, tube-ends, and associated weld (HAZ) locations of the SGs.

(e) Program Element 6, "Acceptance Criteria," does not address or clarify the role of performance criteria, vis-à-vis acceptance criteria, and the related requirements. In addition, it is not clear from the description that any failure to meet a performance criterion means that degradation of a safety barrier has occurred, such that the reporting requirements of Section 50.72 and Section 50.73 are applicable.

(f) Program Element 10, "Operating Experience," may need to address the potential for conditions likely to result in tube denting and add preventive measures or evaluations needed. In addition, OpE following SG replacements (for example at San Onofre-2 and- 3 and TMI-1) should be discussed.

The AMP implemented by Ginna, and by most of the license renewal applicants in general, have been consistent with the GALL AMP XI.M19. Therefore, there have been no industry proposed exceptions or enhancements to this AMP. The Staff's review of the Ginna AMP implementation indicated that the SG plant procedures may include exemptions from 10 CFR 50.59 requirements, suggesting the need for LRGDs to further clarify that the AMPs and

activities summarized in the UFSAR are, in fact, subject to the requirements of 10 CFR Part 50.59.

This review of plant implementation did not identify any specific good practice or strength of the AMP.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.18.4 Recommendations for Subsequent License Renewal

4.2.18.4.1 Good Practices or Strengths of AMP XI.M19

No specific good practice was identified during the review.

4.2.18.4.2 Areas of AMP XI.M19 for Further Consideration/Enhancement

Program Description:

M18.0-1: *Recommendation*: Add clarification emphasizing the need for timely updates to the AMP implementation in accordance with the basis documents and related requirements, which continue to undergo frequent revisions. In addition, confirm and include in the description the aging effects being managed under this AMP (and which are not covered but may be relevant: e.g., cracking due to metal fatigue).

***Technical Basis*:** The primary documents covering the technical basis are the various EPRI guidelines referenced in NEI 97-06. Even at the time Rev. 2 of NEI 97-06 was issued (September 2005) these documents were regarded as "open" references (i.e., work in progress). These documents have undergone, and continue to undergo, revisions that need to be identified and updated as part of the AMP. These revisions to basis documents incorporate more recent experience, enhancements, and research findings of significance to the effective implementation of NEI 97-06 guidelines for the SG AMP. For example, the current industry guidelines, dated January 2011, are in Rev. 3 of NEI 97-06 and the changes in Rev. 3 include (a) removal of "requirements" in NEI 97-06 that are now located in other industry documents (e.g., NEI 03-08 and the EPRI guidelines referenced in NEI 97-06), (b) corrections to definitions, and (c) corrections for inconsistencies with requirements in the technical specifications.

1. Scope of Program:

M18.1-1: *Recommendation*: Revise the AMP scope to adequately reflect on the importance of tube support structures, although these may be viewed as part of secondary side internals. In addition, the scope should include other SG internals (on the primary side) – nickel-based (cladded) divider plate/tubesheet, associated welds/HAZ, and welded tube-ends – that have shown susceptibility to PWSCC.
***Technical Basis*:** The condition and integrity of tube supports, especially including their intersections with the tubes, have direct impacts on the concurrent integrity of multiple tubes. These supports and locations are important in their own way. The nickel-based (cladded) divider plate/tubesheet, associated welds/HAZ, and welded tube-ends are susceptible to PWSCC, and these are SG internal components necessary to maintain SG functionality and the leakage barrier. The confirmed PWSCC in the noted areas of the SGs, at least under certain conditions of fabrication and design, has the potential to be of generic nature during LTO.

Aging-related activities of detection and management of this PWSCC do not appear to be well recognized or formally included in the current scope description.

2. <u>Preventive Action</u>:

M18.2-1: *Recommendation*: Revise the program element to expand the actions needed for managing aging effects of foreign objects in the SGs; include a broader and more explicit program of preventive action(s) and formal evaluation of foreign object(s) on the secondary and primary side as part of this AMP.
***Technical Basis*:** Foreign objects left in service have caused degradation of tubes, mostly on the secondary side, although some primary side damage has been noted leading to PWSCC on the divider plate. Plants (e.g., Ginna) using older revisions of the GALL Report may not formally include the foreign material exclusion (FME) program noted in the Rev. 2 version of the GALL Report, as part of the SG AMP. In addition, the NEI 97-06 indicated use of EPRI SG Examination Guidelines for this activity is for recording any evaluation(s) and not for the evaluation itself (unless updated guidelines address and are implemented to do the evaluation of foreign-objects-related degradation). Although the current GALL AMP element includes am FME program action item, its focus is on the secondary side, with less clarity regarding similar action on the primary side. Program element actions do not include, or provide guidance for, any formal (engineering) evaluation of foreign objects to prevent further (continued) degradation so as to allow for its timely management. As such, it seems relevant that a broader and more explicit program of preventive action(s) and formal evaluation of foreign object(s) on secondary and primary side be included as part of this AMP.

3. <u>Parameters Monitored/Inspected</u>:

M18.3-1: *Recommendation*: Add a description the specific off-normal chemistry parameters to be monitored and the need for periodic assessment of their cumulative impact. In addition, note and/or clarify their significance with particular reference to the secondary-side degradation issues for Alloy 690 (that is optimized for its PWSCC resistance).
***Technical Basis*:** Virtually all PWRs will enter the PEO with replacement SGs having thermally treated (TT) Alloy 690 tubes, though a few may have Alloy 600 TT tubes. This AMP element notes that Alloy 690 TT tubes have only experienced tube degradation due to mechanically induced phenomena (primarily wear) and have not been subject to primary water SCC or outer-diameter SCC. However, there is no assurance that Alloy 690 TT tubes will continue to be free from SCC during the PEO or LTO. This is more applicable for off-normal chemistry incursions (with sulfur or lead-bearing components) and for the secondary-side chemistry/crevice conditions. In addition, the inspection and condition monitoring requirements of this AMP should remain in full force during the PEO despite the apparent (expected) increased resistance of Alloy 690 TT SG tubes to PWSCC.

M18.3-2: *Recommendation*: Clarify/expand (or remove) the reference to fatigue of tubes, and/or provide guidance on managing the fatigue issue for all tubing materials, since this aging effect is not covered elsewhere in this AMP and since it is unlikely to be limited to only mill-annealed Alloy 600 (as noted).
***Technical Basis*:** The reference to fatigue in mill-annealed Alloy 600 tubing seems isolated from the rest of the AMP and from the other tubing materials. If significant, this aging effect is unlikely to be limited to only mill-annealed Alloy 600 (as noted).

4. <u>Detection of Aging Effects</u>:

M18.4-1: *Recommendation*: Include (clarify) or address the need for effective means of detection of degradation in the (cladded) tubesheet, divide plate, tube-ends, and associated weld (HAZ) locations of the SGs.
***Technical Basis*:** The absence of formal inclusion and discussion of managing the degradation in the (cladded) tubesheet, divide plate, tube-ends, and associated weld (HAZ) locations is of concern for the PEOs. For instance, Alloy 82 cladding on the tubesheet is susceptible to PWSCC; this susceptibility may extend into the autogenous tube-to-tubesheet welds due to dilution of the Alloy 690 tubing material with the Inconel 82. There is no well-qualified eddy current inspection technique at present for these welds/locations, which adds inspectability concerns to the associated potential PWSCC issue. More direct and notable coverage of detecting and managing the aging effects of stated locations during the PEO and LTO should add to the effectiveness of implementation of this AMP.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M18.6-1: *Recommendation*: Address or clarify the role of integral performance criteria vis-à-vis acceptance criteria, and the related requirements. Note that any failure to meet a performance criterion means that degradation of a safety barrier has occurred, such that the reporting requirements of Section 50.72 and Section 50.73 are applicable.
***Technical Basis*:** Acceptance criteria, in the general context of this AMP, also refer to meeting the various performance criteria described in various basis documents (primarily, the EPRI guidelines). In addition, SG tube-integrity-related technical specifications require (and/or presume) compliance with the SG performance criteria. In addition, it is not clear from the description of this program element that any failure to meet a performance criterion means that degradation of a safety barrier has occurred, such that the reporting requirements of Section 50.72 and Section 50.73 are applicable.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M18.10-1: *Recommendation*: Review the potential for conditions likely to result in denting and add preventive measures or evaluations needed for its management.
***Technical Basis*:** While tube denting is not a new degradation mechanism, its re-appearance (e.g., Ginna experience) and potential consequences for tubing SCC/IGA/PWSCC, even with

Alloy 690, due to potential for high stressing conditions, and in combination with possible caustic (crevice) conditions if large enough sludge accumulation/hardening is allowed to remain, are of concern. Tube denting, if undetected or uncorrected, has significant ramifications over LTO for tube integrity and any inspection interval(s) based on the assumption of its non-occurrence.

M18.10-2: *Recommendation*: Primary side fouling does not appear to be confirmed as an aging effect to be covered in this AMP.
***Technical Basis*:** Primary side fouling within SG was noted in the Ginna program description and a few other LRAs in the past. These instances were noted either because of the use of an older generic GALL template or a misunderstanding of GALL requirements (as concluded in TSTF-510 update: ML110490077).

4.2.19 Open Cycle Cooling Water System (XI.M20)

4.2.19.1 Objective and Scope of Rev. 2 AMP XI.M20

The program relies on implementation of the recommendations of GL 89-13 to ensure that the effects of aging on the OCCW (or service water) system will be managed for the PEO. GL 89-13 defines the OCCW system as a system or systems that transfer heat from safety-related SSCs to the ultimate heat sink (UHS). The guidelines of GL 89-13 for managing an OCCW include (a) surveillance and control of biofouling (see Chapter IX of NUREG-1801); (b) a test program to verify heat transfer capabilities; (c) routine inspection and a maintenance program to ensure that corrosion, erosion, protective coating failure, sediment deposition (silting), and biofouling cannot degrade the performance of safety-related systems serviced by OCCW; (d) a system walkdown inspection to ensure compliance with the licensing basis; and (e) a review of maintenance, operating, and training practices and procedures.

In accordance with the guidance of GL 89-13, the OCCW AMP manages aging effects of components in raw water systems, such as the service water or river water, by using a combination of preventive, condition, and performance monitoring activities. These include (a) surveillance and control techniques to manage aging effects caused by biofouling, corrosion, erosion, protective coating failures, and silting in the OCCW system or structures and components serviced by the OCCW system; (b) inspection of critical components for signs of corrosion, erosion, and biofouling; and (c) testing of the heat transfer capability of heat exchangers that remove heat from components important to safety.

For buried OCCW piping, the aging effects on the external surfaces are managed by XI.M41, but the internal surfaces are managed by this program. The aging management of closed-cycle cooling water (CCCW) systems is described in XI.M21A, “Closed Treated Water Systems,” and is not included as part of this program. The OCCW system program applies to components constructed of various materials, including steel, SS, aluminum, copper alloys, titanium, polymeric materials, and concrete. Piping may be lined with internal coatings or unlined.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) GL 89-13, *Service Water System Problems Affecting Safety-Related Components*, July 18, 1989; and
(ii) GL 89-13, Supplement 1, *Service Water System Problems Affecting Safety-Related Components*, April 4, 1990.

4.2.19.2 Observations from Ginna and NMP-1

This program is implemented at Ginna through its AMP B2.1.22, “Open-Cycle Cooling (Service Water) System.” The Ginna AMP contains two exceptions to AMP XI.M20 of the GALL Report, Rev. 0, detailed in the AEA TLR, ML13122A009. Both Ginna AMP B2.1.22, Service Water System Reliability and Optimization, and the amended NMP-1 AMP B2.1.10, Open Cycle Cooling Water System Program, cite the guidance given in NRC GL 89-13 and 10 CFR Part 50, Appendix B, which is also included in the GALL Report, Rev. 2.

It was noted during the Ginna audit that increased roughness was observed on the inner surfaces of open-cycle cooling water (OCCW) system piping due to the formation of tubercles and other ongoing fouling mechanisms. This aging mechanism impacted the piping internal roughness assumptions used in developing acceptance criteria for the safety-related supply in the auxiliary feedwater system. Specifically, due to the increased roughness from this aging mechanism, the Ginna staff noted that the current acceptance criteria established for pressure

requirements may not provide sufficient flow through the affected piping in the event of a loss of coolant accident (LOCA). Since this configuration is not tested due to the adverse effects of introducing raw water into the SGs, additional steps may need to be taken to address this aspect.

NMP-1 implements this program through its AMP B2.1.10, "Open Cycle Cooling Water System Program." The NMP-1 AMP identifies no exceptions, but includes enhancements, detailed in ML13122A009.The document noted that variations made the heat exchangers uninspectable with conventional eddy current technique and stated that pressure tests from the shell side verified no tube leakage. Other changes to some of the implementing procedures were noted, but these did not appear to be the result of specific problems with the program or the result of enhancements due to aging-related operating experience.

The July–September 2011 System Health Report for the service water system at NMP-1 noted that heat exchanger performance was very good, but discussed the condition of the emergency service water piping condition and the need to replace 14-in. diameter discharge piping because of wall thinning. It also noted that much of the small-bore piping is in "a generally degraded condition." As a result, through-wall leaks occur at an "unacceptable" frequency of approximately one per year for 3-in. and smaller diameter piping. Furthermore, the frequency of leaks is increasing. The report also stated that the current practice at NMP-1 is to repair service water piping leaks when they occur. The licensee subsequently stated that funding has been approved to replace all 3-in or less diameter piping from 2015 through 2020. The 14-in. diameter emergency service water discharge piping is also funded for replacement over the next two RFOs in 2013 and 2015.

4.2.19.3 Effectiveness of AMP XI.M20 to Meet Its Objective

The audit reports from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.19, "AMP Worksheet XI.M20 Open-Cycle Cooling Water System." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.19.4.

4.2.19.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The guidance provided in GALL under GL 89-13 and its Supplement 1 is subject to possible future updates. The program description makes no mention of the possibility of such future updates, nor does it state that the applicant should revise its OCCW system program to remain in conformance with the most recent NRC-approved guidance.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M20, with some exceptions and enhancements. The Ginna AMP lists the following two exceptions: (1) heat transfer tests are not performed on selected small heat exchangers that are periodically cleaned and inspected in accordance with the Ginna Periodic Surveillance and Preventive Maintenance Program, and (2) the Ginna AMP does not address protective coatings, which are not credited for aging management in the Ginna Service Water System. The NMP-1 AMP identifies no exceptions, but lists the following enhancements: (1) ensure that the applicable NMP-1 commitments made for GL 89-13, and the requirements in NUREG-1801, Section XI.M20 are captured in the appropriate NMP-1 documents; (2) where the requirements of GALL XI.M20 are more conservative than the GL 89-13 commitments, they will be incorporated into the NMP-1 AMP; and (3) revise the NMP-1 and NMP-2 preventive maintenance and heat transfer performance test procedures to incorporate specific inspection criteria, corrective actions, and frequencies.

The incorporation of the requirements of GALL XI.M20 into the NMP-1 AMP when they are more conservative than the NMP-1 GL 89-13 commitments is considered good practice. Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.19.3.2 Effectiveness and Implementation of AMP XI.M20

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 2, “Scope of Program,” makes no mention of SCC as a degradation mechanism, focusing instead on material loss and fouling. However, copper-zinc (brass >15% zinc) alloys are commonly used in OCCW system heat exchangers as tubing materials. These alloys are susceptible to SCC in contact with component cooling water and service water at temperatures up to 38°C (100°F) max. The aggressive species in the water that could potentially produce SCC in brass components include ammonia, various amines, and chlorides. OpE at nuclear plants should be reviewed to determine if, in fact, SCC has occurred in OCCW brass heat exchanger tubes. If it has occurred, GALL AMP XI.M20 will need to be updated.

(b) Program Element 2, “Scope of Program,” does not directly address increased roughness at the inner surfaces of OCCW system piping due to the formation of tubercles and other ongoing fouling mechanisms. However, this phenomenon was observed in the safety-related auxiliary feedwater supply piping at Ginna, where it impacted the piping internal roughness assumptions used in developing acceptance criteria. Due to the increased roughness from this aging mechanism, it was determined that the current acceptance criteria established for pressure requirements may not provide sufficient flow in the event of a LOCA. Since this configuration is not tested due to the adverse effects of introducing raw water into the SGs, additional steps may need to be taken to address this aspect, and GALL AMP XI.M20 may require updating to address this aging mechanism.

4.2.19.4 Recommendations for Subsequent License Renewal

4.2.19.4.1 Good Practices or Strengths of AMP XI.M20

M19.S-1: *Recommendation*: At NMP-1, the Program Health Report and System Health Report maintains a list of relatively recent plant-specific and industry issues, including those related to the OCCW system, along with the disposition for each item. This activity is considered a good practice and should be considered for inclusion as a part of Program Element 5, "Monitoring and Trending."
***Technical Basis*:** The results of such a system provide a basis for continued improvement of program effectiveness.

4.2.19.4.2 Areas of AMP XI.M20 for Further Consideration/Enhancement

Program Description:

M19.0-1: *Recommendation*: Revise the program description to state explicitly that the applicant should periodically update its OCCW system program to remain in conformance with any possible updates to GL 89-13 and its Supplement 1.
***Technical Basis*:** The GALL Report currently recommends that aging of components in the OCCW system be managed using the guidance provided in GL 89-13 and its Supplement 1. However, this guidance is subject to possible updates that reflect the most recent research results and OpE.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

M19.2-1: *Recommendation*: OpE at nuclear plants should be reviewed to determine if, in fact, SCC has occurred in OCCW brass heat exchanger tubes. If it has occurred, GALL AMP XI.M20 will need to be updated.
***Technical Basis*:** Copper-zinc (brass >15% zinc) alloys are commonly used in OCCW system heat exchangers as tubing materials. These alloys are susceptible to SCC in contact with component cooling water and service water at temperatures up to 38°C (100°F) max. The aggressive species in the water that could potentially produce SCC in brass components include ammonia, various amines, and chlorides.

M19.2-2: *Recommendation*: Evaluate the need to update GALL AMP XI.M20 to address the development of increased roughness at the inner surfaces of OCCW system piping due to the formation of tubercles due to MIC, and other ongoing fouling mechanisms.
***Technical Basis*:** This aging mechanism was observed at Ginna, where it impacted the piping internal roughness assumptions used in developing acceptance criteria. Due to the increased roughness from this aging mechanism, it was determined that the current acceptance criteria established for pressure requirements may not provide sufficient flow in the event of a LOCA. Since this configuration is not tested due to the adverse effects of introducing raw water into the SGs, additional steps may need to be taken to address this aspect.

3. Parameters Monitored/Inspected:

M19.3-1: *Recommendation*: Where OpE, particularly that from the initial 20-year license extension period, indicates that periodic inspections alone are inadequate to maintain heat exchanger performance, heat transfer testing should be required.
***Technical Basis*:** Substantial portions of the internal surfaces of heat exchangers in the OCCW system are often inaccessible for periodic inspections. For example, GALL AMP XI.M20 is implemented at Ginna through its "Service Water System Reliability and Optimization Program" (B2.1.22). As stated in the LRA, this program takes an exception to GALL guidance that calls for heat transfer tests on selected small heat exchangers in the OCCW system; instead, the program relies on periodic cleaning and inspection. However, heat transfer testing provides the only viable alternative for monitoring heat exchanger performance.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

M19.10-1: *Recommendation*: For plants with poor OpE, it is desirable to verify their conformance to the guidance of GL 89-13. If, despite following this guidance, they have experienced significant problems, then the GL 89-13 guidance may require revision. Alternatively, if the poor OpE is the result of failure to follow GL 89-13 guidance, a detailed one-time inspection of the OCCW system and a review of procedures for implementing GL 89-13 guidance may be required prior to entering LTO.
***Technical Basis*:** The July–Sept. 2011 System Health Report for the Service Water System at NMP-1 notes that much of the piping is in "a generally degraded condition." As a result, through-wall leaks occur at an "unacceptable" frequency of approximately one per year for 3-inch and smaller diameter piping. Furthermore, the frequency of leaks is increasing. The report also stated that the current practice at NMP-1 is to repair service water piping leaks when they occur in what appears to be a "run-to-failure" strategy.

4.2.20 Closed Treated Water System (XI.M21A)

4.2.20.1 Objective and Scope of Rev. 2 AMP XI.M21A

NPPs contain many closed, treated water systems. These systems undergo water treatment to control water chemistry and prevent corrosion (i.e., treated water systems). They are also recirculating systems in which the rate of recirculation is much higher than the rate of addition of makeup water (i.e., closed systems). The program includes (a) water treatment, including the use of corrosion inhibitors, to modify the chemical composition of the water such that the function of the equipment is maintained and such that the effects of corrosion are minimized; (b) chemical testing of the water to ensure that the water treatment program maintains the water chemistry within acceptable guidelines; and (c) inspections to determine the presence or extent of corrosion and/or cracking. Depending on the industry standard selected for use in association with this AMP, and/or plant OpE, this program also may include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) GL 89-13, *Service Water System Problems Affecting Safety-Related Components*, July 18, 1989;
(ii) GL 89-13, Supplement 1, *Service Water System Problems Affecting Safety-Related Components*, April 4, 1990;
(iii) EPRI 1007820, *Closed Cooling Water Chemistry Guideline*, 2004; and
(iv) *The Nalco Water Handbook*, Nalco Company, 2009.

4.2.20.2 Observations from Ginna and NMP-1

This program is implemented at Ginna through its AMP B2.1.9, “Closed-Cycle (Component) Cooling Water System.” However, Ginna takes an exception to AMP XI.M21 of the GALL Report, Rev. 0, in that EPRI TR-107396 is not referenced in Ginna procedures, and the only parameters monitored are pH, corrosion inhibitor concentrations, and radioactivity. NMP-1 implements this program through its AMP B2.1.11, “Closed-Cycle Cooling Water System Program.” The NMP-1 program takes no exceptions to AMP XI.M21 of the GALL Report, Rev. 0, but adds a number of enhancements, detailed in the AEA TLR, ML13122A009.

A review of the condition reports for Ginna did not indicate any significant degradation problems in the CCCW system.

The NMP-1 LRA and SER allude to “various forms of degradation” that have occurred in the CCCW system and state that these problems were addressed by increased monitoring, component repair, or component replacement. However, no details on the relevant specific OpE events or the remedial actions were given. A review of the NMP-1 PBD for the CCCW system during the present audit provided those details, including numerous incidents of pipe leaks in the reactor building closed-loop portion of the system that required significant system makeup over time. These included seven incidents of pipe wall thinning from 1996 to 2003 and 10 occurrences of leakage at threaded and mechanical joints from 2001 to 2003. These failures were attributed to a combination of general, galvanic, and flow-accelerated corrosion as well as inadequate design of threaded joints and inadequate wall thickness. There have also been problems over the years with maintaining nitrogen overpressure in the system surge tank. These problems appear to have resulted in higher levels of dissolved oxygen than specified in the CCCW chemistry and consequent corrosion problems. The problems were addressed by replacing the reactor building closed-loop system piping with schedule 80 pipe rather than the original schedule 40 pipe and by the installation of an oxygen removal skid. The absence of

similar events after the implementation of these remedial actions indicates that they have adequately addressed these problems.

The NMP-1 Program Health Report and System Health Report include the results of periodic assessments of the implementation of the NMP CCCW system program, a list of any degradation observed, and a summary of the overall status of the system. The most recent report stated that the AMP is working well, but because of finding degradation in system components, applicable preventive maintenance frequencies have been increased from every third cycle to every cycle.

4.2.20.3 Effectiveness of AMP XI.M21A to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.20, “AMP Worksheet XI.M21A Closed Treated Water Systems.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.20.4.

4.2.20.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M21, with exceptions and enhancements. Ginna takes an exception to GALL, Rev. 0, in that EPRI TR-107396 is not referenced in Ginna procedures, and the only parameters monitored are pH, corrosion inhibitor concentrations, and radioactivity. The NMP CCCW System Program takes no exceptions to GALL, Rev. 0, but adds a number of enhancements to make it consistent with GALL. These enhancements include (1) expanding periodic chemistry checks of CCCW systems consistent with the guidelines of EPRI TR-107396, (2) implementing a program to use corrosion inhibitors in accordance with the guidelines given in EPRI TR-107396, (3) performing periodic inspections to monitor for loss of material in the piping of the CCCW systems, (4) implementing a corrosion monitoring program for larger bore CCCW piping not subject to inspection, (5) establishing inspection frequencies for degradation of components in CCCW Systems, (6) performing a heat removal capability test for the NMP-1 Control Room HVAC System at least every 5 years, (7) establishing periodic monitoring, trending, and evaluation of performance parameters for several CCCW systems, (8) specifying chemistry sampling frequencies for the NMP-2 Control Building Ventilation Chilled Water System, (9) providing the controls and sampling necessary to maintain water chemistry parameters in CCCW Systems within the guidelines of EPRI Report TR-107396, and (10) ensuring that acceptance criteria are specified in the implementing procedures for the applicable indications of degradation.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.20.3.2 Effectiveness and Implementation of AMP XI.M21A

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 3, "Parameters Monitored/Inspected," refers to industry standard guidance documents produced by the EPRI, the American Society of Heating Refrigeration and Air-Conditioning Engineers, the Cooling Technology Institute, the American Boiler Manufacturer's Association, ASTM standards, and water chemistry guidelines recommended by the equipment manufacturer, Nalco Water Handbook, or the ASME. For CCCW systems as defined in GL 89-13, EPRI 1007820 is used. All of these standards are subject to periodic updates. However, Program Element 3 makes no mention of the possibility of such future updates, nor does it state that the applicant should revise its closed treated water system program to remain in conformance with the most recent NRC-approved guidance.

4.2.20.4 Recommendations for Subsequent License Renewal

4.2.20.4.1 Good Practices or Strengths of AMP XI.M21A

M20.S-1: *Recommendation*: At NMP-1, the Program Health Report and System Health Report includes the results of periodic assessments of the implementation the NMP CCCW System Program, lists any degradation observed, and summarizes the overall status of the system. The most recent report stated that the AMP is working well, but as a result of finding degradation in system components, applicable preventive maintenance frequencies have been increased from every third cycle to every cycle.
***Technical Basis*:** The application of such an assessment activity provides a basis for continued improvement of program effectiveness.

4.2.20.4.2 Areas of AMP XI.M21A for Further Consideration/Enhancement

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

M20.3-1: *Recommendation*: Revise this program element to state explicitly that the applicant should periodically update its closed treated water system program to remain in conformance

with any possible updates to the referenced industry guidance.
***Technical Basis*:** Program Element 3 refers to industry standard guidance documents produced by the EPRI, the American Society of Heating Refrigeration and Air-Conditioning Engineers, the Cooling Technology Institute, the American Boiler Manufacturer's Association, ASTM standards, and water chemistry guidelines recommended by the equipment manufacturer, Nalco Water Handbook, or the ASME. For CCCW systems as defined in GL 89-13, EPRI 1007820 is used. All of these standards are subject to periodic updates and outdated industry standards no longer represent optimal operating procedures and practices.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

M20.10-1: *Recommendation*: Enhance the closed treated water system AMP to include a thorough review of plant OpE prior to LTO. Where this OpE indicates water chemistry control problems, require rigorous inspection of the system SSCs and a review of the applicant's chemistry control program.
***Technical Basis*:** The NMP-1 program basis document for the CCCW system reported numerous incidents of pipe leaks. These included seven incidents of pipe wall thinning from 1996 to 2003 and ten occurrences of leakage at threaded and mechanical joints from 2001 to 2003. These failures were attributed to a combination of general, galvanic, and flow-assisted corrosion as well as inadequate design of threaded joints and inadequate wall thickness (schedule 40 rather than the schedule 80 pipe used in replacement). In all cases, the applicant claimed that their CCCW AMP has been effective in detecting and correcting the problems. However, further investigation revealed multiple problems over the years with maintaining nitrogen overpressure in the system surge tank and with multiple system leaks that required significant system makeup over time. These problems appear to have resulted in higher than specified levels of dissolved oxygen in the CCCW chemistry and consequent corrosion problems. This is an aging issue that has potentially significant implications for LTO, since the

CCCW system serves a number of safety-related functions, including EDG cooling, the control room HVAC, and heat exchangers in the shutdown cooling system.

4.2.21 BORAFLEX MONITORING (XI.M22)

4.2.21.1 Objective and Scope of Rev. 2 AMP XI.M22

The objective of this program is to provide AMAs for managing the aging effects of Boraflex panels in the spent fuel pool. The aging effect is the loss of boron carbide in the neutron absorber sheets due to gap formation, degradation of the polymer matrix, and release of silica to the spent fuel pool water. To ensure that the aging effects are managed such that the Boraflex panels maintain neutron-absorbing capability in the extended period of operation, the AMP relies on the following aging AMAs:

(1) Periodic sampling and analysis for silica levels in the spent fuel pool and trending of the results in accordance to guidelines in the NRC IN 95-38 and GL 96-04, to assure that no unexpected degradation of the Boraflex material compromises the criticality analysis in support of the design of spent fuel storage racks. The parameters monitored include physical conditions of the Boraflex panels, such as gap formation and decreased boron areal density, and the concentration of silica in the spent fuel pool.

(2) Performing neutron attenuation testing or blackness testing to determine gap formation in Boraflex panels or measuring boron areal density by techniques such as the BADGER device. The AMAs ensure that the required 5% subcriticality margin is maintained in the PEO.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) NRC IN 95-38 and GL 96-04.

4.2.21.2 Observations from Ginna and NMP-1

Ginna has de-credited Boraflex neutron absorber panels in its spent fuel pool (SFP). In addition to soluble boron, Ginna also relies on borated stainless steel for neutron absorption, and aging of this material is managed by its AMP B2.1.30. Further details are available in the AEA TLR, ML13122A009.

NMP-1 implements this program through its existing AMP B2.1.12, “Boraflex Monitoring Program.” Program activities are detailed in ML13122A009. The enhancements to the NMP-1 program include performing periodic in-situ neutron attenuation testing, which serves to measure boron areal density to confirm the correlation of the conditions of the test coupons to the conditions of the Boraflex racks that remain in use during the PEO. In addition, the program includes monitoring and trending requirements for in-situ test results, silica level, and coupon surveillance test results.

The program manages aging of Boraflex degradation by conducting coupon surveillance testing, performing in-situ neutron attenuation testing and monitoring silica concentration in the SFP. The licensee reported that the correlation between the surveillance test coupons and neutron attenuation testing yielded a close relationship of <1% difference. NRC staff does not agree with comparing the BADGER results to the coupon test results, based on guidance in AMP XI.M22 in GALL Report, Rev. 2, that the results of the coupon test may not be reliable.

The NMP-1 SFP originally had eight Boraflex racks, but only two of these racks remain. Two re-rack campaigns were performed in 1999 and 2004, which replaced most of the original Boraflex and the remaining original equipment non-poison racks with Boral racks.

The silica concentration in the NMP-1 SFP is monitored on a monthly basis for trending. Unpredicted excursion in the rate of increase in silica levels was not observed in this audit.

4.2.21.3 Effectiveness of AMP XI.M22 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.21, "AMP Worksheet XI.M22 Boraflex Monitoring." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.21.4.

4.2.21.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description needs to mention that aging management of spent fuel pools using neutron-absorbing materials other than Boraflex, such as Boral, Metamic, boron steel, and carborundum, is addressed in XI.M40, "Monitoring of Neutron-Absorbing Material Other Than Boraflex."

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M22.

NMP-1 has the following commitments in the SER Appendix A. The Boraflex Monitoring Program will be enhanced to (1) require periodic neutron attenuation testing and measurement of boron areal density to confirm the correlation of the conditions of test coupons to those of Boraflex racks that remain in use during the PEO; and (2) establish monitoring and trending instructions for in-situ test results, silica levels, and coupon results.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.21.3.2 Effectiveness and Implementation of AMP XI.M22

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) SER (NUREG 1900) Section 3.0.3.2.9 of NMP 1 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels.

Because the NMP-1 spent fuel pool has both Boraflex and Boral panels. The AMP needs to provide guidance on the applicability of program elements such as detection of aging effects, acceptance criteria in a spent fuel pool that contains both Boraflex and neutron absorbing materials other than Boraflex.

4.2.21.4 Recommendations for Subsequent License Renewal

4.2.21.4.1 Good Practices or Strengths of AMP XI.M22

No specific good practice was identified during the review.

4.2.21.4.2 Areas of AMP XI.M22 for Further Consideration/Enhancement

Program Description:

M21.0-1: *Recommendation*: Adding a leading paragraph, as below, is recommended:
Many neutron-absorbing materials, such as Boraflex, Boral, Metamic, boron steel, and carborundum, are used in spent fuel pools. This AMP addresses aging management of spent nuclear pools using Boraflex as the neutron-absorbing material. XI.M40, "Monitoring of Neutron-Absorbing Material Other Than Boraflex," addresses aging management of spent fuel pools using neutron-absorbing materials other than Boraflex (e.g., Boral, Metamic, boron steel, and carborundum).
***Technical Basis*:** The program description needs to mention that aging management of spent fuel pools using neutron-absorbing materials other than Boraflex, such as Boral, Metamic, boron steel, and carborundum, is addressed in XI.M40, "Monitoring of Neutron-Absorbing Material Other Than Boraflex."

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M21.4-1: *Recommendation*: Guidance should be added regarding the applicability of this program element in a spent fuel pool that contains both Boraflex and neutron-absorbing materials other than Boraflex.
Technical Basis: NMP-1 SER (NUREG 1900) Section 3.0.3.2.9 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels. Because the NMP-1 spent fuel pool has both Boraflex and Boral panels, the AMP may need some guidance on the applicability of this program element in a spent fuel pool that contains both Boraflex and neutron-absorbing materials other than Boraflex.

5. <u>Monitoring and Trending</u>:

M21.5-1: *Recommendation*: The following statement should be added:
Silica concentration in the spent fuel pool water serves as an indicator to the amount of Boraflex dissolution occurring in the spent fuel racks. It is important to trend the silica concentration against time and monitor for rapid silica excursions that could indicate accelerated Boraflex degradation.
Technical Basis: The NMP-1 preliminary AEA report states, "Silica concentration in the spent fuel pool water serves as an indicator to the amount of Boraflex dissolution occurring in the spent fuel racks. It is important to trend the silica concentration against time and monitor for rapid silica excursions indicating accelerated Boraflex degradation. Trending the silica concentration is important as stated in the NMP-1 Preliminary AEA report."

6. <u>Acceptance Criteria</u>:

M21.6-1: *Recommendation*: Provide guidance on the acceptance criteria for spent fuel racks for a spent fuel pool containing both Boraflex and non-Boraflex neutron-absorbing materials.
Technical Basis: NMP-1 SER (NUREG 1900) Section 3.0.3.2.9 of states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels. Because the NMP-1 spent fuel pool has both Boraflex and Boral panels, the AMP needs to provide guidance and clarification on whether the acceptance criteria of 5% subcriticality margin of the spent fuel racks is still valid for a spent fuel pool containing both Boraflex and non-Boraflex neutron-absorbing materials.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

No further review item identified.

4.2.22 Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems (XI.M23)

4.2.22.1 Objective and Scope of Rev. 2 AMP XI.M23

The objective of this program is to provide AMAs for managing the aging effects for overhead heavy load and light load (related to refueling) handling systems. This program is primarily concerned with structural components that make up the bridge, trolley, rails, stops, and lifting devices. To ensure that cranes are capable of sustaining their rated loads and the aging effects are managed in the PEO, the AMP relies on the following AMAs:

(1) Crane rails and structural components are visually inspected at a frequency in accordance with ASME B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)," or other appropriate standard in the ASME B30 series. For systems that are infrequently in service, such as containment polar cranes, periodic inspections are performed once every refueling cycle just prior to use.

(2) Visual inspection activities are performed by personnel qualified in accordance with controlled procedures and processes. Deficiencies are documented using applicant-approved processes and procedures. Bolted connections are visually inspected for loose bolts or missing nuts at the same frequency as crane rails and structural components.

(3) Any visual indication of loss of material due to corrosion or wear and any visual sign of loss of bolting pre-load is evaluated according to ASME B30.2 or other applicable industry standard in the ASME B30 series.

The NRC Generic Safety Issues186 (Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants) described in the NUREG-0933 related to high risk of load drop and several significant wire rope failures in recent years are contained in the NRC IN 2009-20, "Degradation of Wire Rope Used in Fuel Handling Applications."

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME B30.2 or other applicable industry standard in the ASME B30 series; and
(ii) The NRC Generic Safety Issues186 (Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants) described in NUREG-0933 and NRC IN 2009-20.

4.2.22.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.18, "Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems," and NMP-1 through its existing AMP B2.1.13, "Inspection of Overhead Heavy Load and Light Load Handling Systems Program."

The AMP at Ginna is mainly a visual and external surface monitoring program to detect corrosion or wear of equipment that is primarily used during refueling outages to lift spent fuel from the SFP. All cranes are inspected annually, except for cranes in containment, which are inspected on 18-month cycles during outages. Further details are available in the AEA TLR, ML13122A009.

During the audit, the licensee stated that the cranes at Ginna are indoors and that no corrosion has ever been found during inspections. One crane failure has occurred at Ginna and that was during original construction. This failure was due to human error and was not aging related.

Most cranes are visually accessible for inspection. The inspection frequency is consistent with the GALL Report.

The program at NMP-1 includes: (a) performance of various maintenance activities on a specified frequency; and (b) pre-operational inspections of equipment prior to lifting activities. The program is consistent with AMP XI.M23 of the GALL Report, Rev. 0, after incorporating an enhancement requiring pre-lift corrosion inspections of certain hoist lifting assembly components. The audit did not find any major issues and no new aging effect was identified for SLR.

4.2.22.3 Effectiveness of AMP XI.M23 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.22, “AMP Worksheet XI.M23 Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.23.4.

4.2.22.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The NRC IN 2009-20 reports several significant cases of wire rope failures due to fatigue and difficulties of inspection. The program description may need to include AMAs associated with these events.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M23.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.22.3.2 Effectiveness and Implementation of AMP XI.M23

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The NRC IN 2009-20 contains several significant wire rope failures due to fatigue and difficulties in inspections. The AMP should be enhanced to provide AMAs for managing fatigue and difficulties in inspection based on experience of those failure cases.

4.2.22.4 Recommendations for Subsequent License Renewal

4.2.22.4.1 Good Practices or Strengths of AMP XI.M23

No specific good practice was identified during the review.

4.2.22.4.2 Areas of AMP XI.M23 for Further Consideration/Enhancement

Program Description:

M22.0-1: ***Recommendation*:** The program description should be expanded to address the recent significant cable wire rope failures due to fatigue and adequacy inspections as addressed in IN 2009-20 (see Item M23.10-1 of OpE in this worksheet).
***Technical Basis*:** NRC IN 2009-20 reports several significant cases of wire rope failures due to fatigue and inadequacy of inspection. The program description needs to mention cable failures due to fatigue.

M22.0-2: ***Recommendation*:** The following existing statements should be removed: "Most commercial nuclear facilities have between 50 and 100 cranes. Many are industrial-grade cranes, which meet the requirements of 29 CFR Volume XVII, Part 1910, and Section 1910.179. Most are not within the scope of 10 CFR 54.4 and therefore are not required to be part of the integrated plant assessment. Because only a few cranes operate over safety-related equipment, normally fewer than 10 cranes fall within the scope of 10 CFR 54.4. Many of the systems and components of these cranes perform an intended function with moving parts or with a change in configuration or are subject to replacement based on qualified life. In these instances, these types of crane systems and components are not within the scope of this aging management program."
The following statements should be added:
"In nuclear plant operation, maintenance, and refueling activities, heavy loads may be handled in several plant areas. If these loads were to drop because of human error or crane failure, they could cause impacts on stored spent fuel, fuel in the core, or equipment that may be required to achieve safe shutdown or permit continued decay heat removal. In some instances, load drops at specific times, locations, and weights could potentially lead to offsite doses that exceed 10 CFR Part 100 limits. Many spent fuel pools are approaching their capacity and are planning to move the spent fuel to long-term dry storage casks. It is reasonable to expect increasing usage of overhead load handling systems to hoist and transport spent fuels and dry storage casks in the PEO."
NRC Generic Safety Issue186 (Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants) in NUREG-0933 indicates that, in general, heavy load drops in BWR plants are more risk significant than those in PWR plants because of plant system layout. For PWRs, spent fuel cask transfers occur near ground level in an area separate from the reactor building and many safety-related systems. However, for BWRs, heavy loads are commonly lifted and moved on the upper floor of the reactor building or the auxiliary building. If a floor is breached by a load drop, many safety-related components located on the lower floors could be disabled."
***Technical Basis*:** NRC Generic Safety Issue 186 (Potential Risk and Consequences of Heavy Load Drops in Nuclear Power Plants) in NUREG-0933 points out the high risk of load drop, and IN 2009-20 contains descriptions of several significant wire rope failures. The AMP program description should be enhanced.

M23.0-3: *Recommendation*: Include bridge stops and lifting devices, in addition to bridge rails, bridge, and trolley in the program description.
***Technical Basis*:** The bridge stops and lifting devices are not mentioned in the program description. However, wire ropes (part of lifting devices) have experienced several significant failures, as described in NRC IN 2009-20.

1. <u>Scope of Program</u>:

M22.1-1: *Recommendation*: Expand the scope of program to include aging management of cables and wires due to fatigue and revise the AMP table.
Technical Basis: Several cases of significant cable failures due to fatigue in recent years are reported in NRC IN 2009-20.

M22.1-2: *Recommendation*: Include bridge stops and lifting devices in addition to bridge rails, bridge, and trolley in the scope of the program.
***Technical Basis*:** The bridge stops and lifting devices are included in the scope of the Ginna AMP. Lifting devices include wire rope, which has experienced several significant failures in recent years as reported in NRC IN 2009-20.

2. <u>Preventive Action</u>:

M22.2-1: *Recommendation*: Wire rope twist should be properly controlled during the reeving process for preventing fatigue damage from uneven load distribution on the distorted wire rope.
Technical Basis: NRC IN 2009-20 recommends proper control of the wire rope twist during the reeving process for preventing fatigue damage from uneven load distribution on the distorted wire rope.

3. <u>Parameters Monitored/Inspected</u>:

M22.3-1: *Recommendation*: Add SCC for monitoring in addition to loose bolts, missing or loose nuts, and other conditions indicative of loss of preload.
Technical Basis: High-strength bolts could experience SCC.

4. <u>Detection of Aging Effects</u>:

M22.4-1: *Recommendation*: Add SCC for monitoring and inspection in addition to loose bolts, missing or loose nuts.
Technical Basis: High-strength bolts could experience SCC.

M22.4-2: *Recommendation*: Expand the program element to provide guidance on aging management of the fatigue of wire ropes.
***Technical Basis*:** Several significant cases of wire rope failures due to fatigue in recent years are reported in NRC IN 2009-20.

M22.4-3: *Recommendation*: Add the following statements to the strength detection of aging effects on aging management of fatigue of the wire ropes:

> "Nuclear power plants use wire ropes in a broad range of material handling applications, including fuel handling, refueling, and dry storage. Safe conduct of these activities depends on the retention of adequate strength in the wire rope supporting the load. A wire rope's strength comes from the integration of several individual wire strands into a well-ordered

structure. Damage to multiple wire strands in a single location or loss of the well-ordered structure results in a substantial reduction in strength and the potential for rope failure.

Fatigue is a common cause of wire rope damage in nuclear plant fuel handling applications. Each time the wire rope bends and returns to a straight configuration, it undergoes a complete bending cycle. The wire strands on the outside of the bend experience the greatest change in stress, and this stress is concentrated at points where individual wires in the outer wire strands pass over an inner wire strand. Repeated bending cycles lead to hardening and subsequent brittle failure of individual wires. Thus, fatigue failure is more likely to occur in regions of the wire rope subject to the most frequent bending (i.e., wire rope that passes around the most sheaves) during operation.

As multiple wires fail in a single location, the load increases the stress on the remaining intact wires. Eventually, the remaining wires may have insufficient strength to support the load, and tensile overload may cause the last remaining wires to fail in a ductile manner.

Thus it is important to perform periodic inspections of the wires locations that are subjected to frequency bending cycles."

Technical Basis: Several significant cases of wire rope failures due to fatigue in recent years are reported in the NRC IN 2009-20. The failure locations were observed in the regions subject to frequent bending that result in fatigue failure.

M22.4-4: *Recommendation*: Add the following statements to strength detection of aging effects in the regions that are difficult to inspect, such as underwater locations near the sheaves:

"NRC IN 2009-20 recommends that in situations where inspections are difficult, staggered replacement can be considered (i.e., replacement of individual wire ropes at widely separated times) or early simultaneous wire rope replacement (i.e., replacement of both ropes well before wire rope replacement criteria are satisfied) to avoid operation with both wire ropes in a severely degraded state. IN 2009-20 also recommends proper control of the wire rope twist during the reeving process for preventing fatigue damage from uneven load distribution on the distorted wire rope."

Technical Basis: Several significant cases of wire rope failures in recent years were caused by difficulty of inspection (e.g., difficulty caused by underwater locations near the sheaves), as reported in the NRC IN 2009-20.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

M22.6-1: *Recommendation*: Include examples of corrective actions from the recent wire rope failure events as described in NRC IN 2009-20, such as the following:

- Fleet-wide inspection of wire rope in similar use and establishment of a program to replace the wire ropes on a set frequency.

- Establish new repetitive preventive-maintenance tasks to perform fuel transfer equipment cable and sheave inspections

- Enhance inspection schedule to monitor the condition of the distorted wire rope until the rope could be replaced.

***Technical Basis*:** These corrective actions are based on industry experience in these wire rope failure cases as described in the NRC 2009-20.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M22.10-1: *Recommendation*: Expand the program element to include the three wire rope failure cases described in NRC IN 2009-20, "Degradation of Wire Rope Used in Fuel Handling Applications." This OpE would provide useful information for enhancing the AMP.

(1) In January 2009, the LaSalle station experienced a partial failure (broken wire strands) of one of two wire ropes in the refueling machine. The broken wire strands occurred at a point that was subject to bending and was difficult to inspect because it was located at an end fitting. The failure was caused by fatigues. Failure of both of the redundant wire ropes could result in release of radioactive material. The corrective actions included fleet-wide inspection of wire rope in similar use and establishment of a program to replace these wire ropes on a set frequency.

(2) In October 2007, the Beaver Valley station experienced a complete failure of the sole wire with a new fuel assembly in the up-ender. The failure occurred at a wire location that was subject to repeated bending around two closely-spaced sheaves, and difficult to inspect because of the underwater location near the sheaves. Failure was caused by fatigue and could result in a release of radioactive material. Corrective actions included establishing new repetitive preventive-maintenance tasks to perform fuel transfer equipment cable and sheave inspections.

(3) On October 4, 2007, the Browns Ferry station experienced a distortion (untwisting) of the wire rope structure in one of the two redundant reeving systems that support heavy loads moved on the refueling floor. Distortion of the wire rope structure increased the potential for failure under load as the individual strands are less likely to share the load evenly. An enhanced inspection schedule was established to monitor the condition of the wire rope until the distorted rope could be replaced.

The NRC IN 2009-20 recommends that in situations where inspections are difficult, staggered replacement can be considered (i.e., replacement of individual wire ropes at widely separated

times) or early simultaneous wire rope replacement (i.e., replacement of both ropes well before wire rope replacement criteria are satisfied) to avoid operation with both wire ropes in a severely degraded state. IN 2009-20 also recommends proper control of the wire rope twist during the reeving process for preventing fatigue damage from uneven load distribution on the distorted wire rope.

***Technical Basis*:** Several significant events of wire rope failures are reported in NRC IN 2009-20. These events could result in release of radioactive material. Fatigue failure and difficulty of inspection were common causes of the events. Useful measures for preventing rope degradation are provided in IN 2009-20.

4.2.23 Compressed Air Monitoring (XI.M24)

4.2.23.1 Objective and Scope of Rev. 2 AMP XI.M24

The purpose of the compressed air monitoring program is to provide reasonable assurance of the integrity of the compressed air system. The program consists of monitoring moisture content, corrosion, and performance of the compressed air system. This includes (a) preventive monitoring of water (moisture) and other potential contaminants to keep within the specified limits; and (b) inspection of components for indications of loss of material due to corrosion.

The compressed air monitoring AMP is based on results of the plant owner's response to GL 88-14 (as applicable to license renewal) and reported in NRC IN 81-38; IN 87-28; IN 87-28, Supplement 1; and by the Institute of Nuclear Power Operations Significant Operating Experience Report 88-01. GL 88-14, issued after several years of study of problems and failures of instrument air systems, recommends that each holder of an operating license perform an extensive design and operations review and verification of its instrument air system. GL 88-14 also recommends that the licensees describe their program for maintaining proper instrument air quality. This AMP does not include all aspects of GL 88-14 because many of the issues in the GL are not relevant to license renewal.

This AMP does not change the applicant's docketed response to GL 88-14 for the rest of its operations. The program utilizes the aging management aspects of the applicant's response to GL 88-14 for license renewal with regard to preventative measures, inspections of components, and testing to ensure that the compressed air system will be able to perform its intended function for the PEO. The AMP also incorporates the air quality provisions provided in the guidance of EPRI NP- 7079, which was issued in 1990 to assist utilities in identifying and correcting system problems in the instrument air system and to enable them to maintain required industry safety standards. ASME OM-S/G-1998, Part 17 provides additional guidance for maintenance of the instrument air system by offering recommended test methods, test intervals, parameters to be measured and evaluated, acceptance criteria, corrective actions, and records requirements.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) GL 88-14, *Instrument Air Supply Problems Affecting Safety-Related Components*, August 8, 1988;
(ii) NRC IN 81-38, *Potentially Significant Components Failures Resulting from Contamination of Air-Operated Systems*, December 17, 1981;
(iii) NRC IN 87-28, *Air Systems Problems at U.S. Light Water Reactors*, June 22, 1987;
(iv) NRC IN 87-28, Supplement 1, *Air Systems Problems at U.S. Light Water Reactors*, 1987;
(v) ASME OM-S/G-1998, Part 17, *Performance Testing of Instrument Air Systems Information Notice Light-Water Reactor Power Plants*, 1ISA-S7.0.1-1996, "Quality Standard for Instrument Air," 1998;
(vi) EPRI NP-7079, *Instrument Air System: A Guide for Power Plant Maintenance Personnel*, December 1990; and
(vii) INPO Significant Operating Experience Report 88-01, *Instrument Air System Failures*, May 18, 1988.

4.2.23.2 Observations from Ginna and NMP-1

Ginna states in its LRA that the air-operated valves in the plant were verified to be fail-safe on loss of air, that the compressed air systems at Ginna did not perform a safety function, and

therefore the Ginna air systems are not within the scope of license renewal. During this audit, the licensee stated that aging effects on components within the system were managed through the site's AMP B2.1.33, "System Monitoring."

A self-assessment of the instrument air system was performed in 2010, which evaluated the adequacy of the current program with recommendations 4 and 5 given in SOER 88-1, "Instrument Air System Failures." The licensee identified eight improvements during its assessment to strengthen the program. In addition, condition reports including receiver tank wall thickness measurements indicated that the program was adequately identifying issues. An independent review of Ginna OpE did not indicate any significant problems in the compressed air system.

NMP-1 implements this program through its AMP B2.1.14, "Compressed Air Monitoring Program." NMP-1 made specific exceptions to any maintenance recommended in EPRI TR-108147 that is not also endorsed by the equipment manufacturers, and to the preservice and guidelines of ASME OM-S/G-1998, Part 17. NMP-1 also added several enhancements, detailed in the AEA TLR, ML13122A009.

At NMP-1, comprehensive visual walkdown inspections of the compressed air system components are performed at 2-year intervals, based on the plant's refueling cycle, and monthly walkdowns of selected components accessible during plant operation. Instrument air sampling components are inspected at either 3- or 6-month intervals. Internal and external cracking of red brass components in the system has been a problem in the past, and all of the red brass components in the system have since been replaced. No other significant component replacements have taken place.

4.2.23.3 Effectiveness of AMP XI.M24 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.23, "AMP Worksheet XI.M24 Compressed Air Monitoring." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.23.4.

4.2.23.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M24, with exceptions and enhancements. Ginna did not credit its Compressed Air Monitoring Program for managing or monitoring aging effects for SSCs within the scope of license renewal, but instead relied upon its Systems Engineering Program. NMP made specific exceptions to any

maintenance recommended in EPRI TR-108147 that is not also endorsed by the equipment manufacturers, and to the preservice and IST guidelines of ASME OM-S/G-1 998, Part 17. NMP also added the following enhancements: (1) develop new activities to manage the loss of material and SCC, and perform periodic system leak checks; (2) expand the scope, periodicity, and inspection techniques to ensure that the aging of certain sub-components of the dryers and compressors are managed; (3) develop and implement activities to address the failure mechanism of SCC in unannealed red brass piping; (4) establish activities that manage the aging of the internal surfaces of CS piping and that require system leak checks to detect deterioration of the pressure boundaries; and (5) expand the acceptance criteria to ensure that the aging of certain subcomponents of the dryers and compressors are managed.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.23.3.2 Effectiveness and Implementation of AMP XI.M24

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, "Scope of Program," states that the program manages the aging effects of loss of material due to corrosion in compressed air systems. However, Ginna did not credit this program for monitoring or managing aging effects of components within the scope of license renewal. Instead, the LRA cites the applicant's June 17, 1991, response to GL 88-14, which stated that air-operated valves at Ginna were verified to fail-safe on loss of air, and that therefore the compressed air systems at Ginna did not perform a safety function. During the LTO audit, the licensee stated that aging effects on components within the system were managed through the site's system engineering program. Plant condition reports, including receiver tank wall thickness measurements, indicated that the program was effectively identifying issues.

(b) Program Element 2, "Preventive Actions," specifies maintenance activities to maintain contaminants below levels specified in industry standards. However, NMP-1 made an exception to any maintenance recommended in EPRI TR-108147 that is not also endorsed by the equipment manufacturers and to the pre-service and inservice testing guidelines of ASME OM-S/G 1998, Part 17. The justification for these exceptions is that there have been no age-related failures in this system under the current program. In general, the compressed air system at NMP-1 has been relatively trouble-free. The exception is that internal and external cracking of red brass components in the system has been observed in the past, and all of the red brass components in the system have since been replaced. It was subsequently determined that red brass should not have been used in the first place, but it was apparently introduced through fabricator or vendor error.

4.2.23.4 Recommendations for Subsequent License Renewal

4.2.23.4.1 Good Practices or Strengths of AMP XI.M24

M23.S-1: *Recommendation*: Ginna performed a self-assessment of the instrument air system in 2010 that evaluated the adequacy of the current program with recommendations 4 and 5 given in SOER 88-1, "Instrument Air System Failures." The licensee identified eight improvements during their assessment to strengthen the program. This activity is considered

good practice and should be included as a part of Program Element 5, “Monitoring and Trending.”
***Technical Basis*:** The results of such self-assessments provide a basis for continued improvement of program effectiveness.

4.2.23.4.2 Areas of AMP XI.M24 for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

M23.1-1: *Recommendation*: Consider requiring the development of a separate, stand-alone AMP to manage aging in the compressed air system for all plants applying for LTO.
***Technical Basis*:** The Ginna LRA contains only a summary description of its Compressed Air Monitoring Program, and the applicant did not credit this program for monitoring or managing aging effects of components within the scope of license renewal. Instead, the LRA cites the applicant’s June 17, 1991, response to GL 88-14, which stated that air-operated valves at Ginna were verified to fail-safe on loss of air, and that therefore the compressed air systems at Ginna did not perform a safety function. During the LTO audit, the licensee stated that aging effects on components within the system were managed through the site’s system engineering program. The absence of a stand-alone AMP to manage component aging in the compressed air system raises concerns for LTO. Even though the compressed air system may be identified as not directly performing a safety-related function, the compressed air provides the motive power for instruments and active components (some of them safety-related) that may not function properly if nonsafety Group D equipment is contaminated.

2. Preventive Action:

M23.2-1: *Recommendation*: Revise this program element to state explicitly that the applicant should periodically update its compressed air monitoring program to remain in conformance with any possible updates to the industry standards cited here.
***Technical Basis*:** The GALL Report currently recommends that aging of components in the OCCW system be managed using the guidance provided in the industry standards cited in Program Element 2. However, these standards are subject to possible updates that reflect the most recent research results and OpE.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M23.10-1: *Recommendation*: Revise AMP XI.M24 as necessary for LTO in response to future OpE.
***Technical Basis*:** Aside from some notable exceptions, OpE with the compressed air systems in nuclear plants has been generally favorable. However, it is essential to continue to closely monitor future industry and plant-specific OpE, particularly during the initial 20-year license extension period. Any increase in component degradation in the compressed air systems will require a reevaluation and possible revision of the current AMP XI.M24 before it is applied to LTO.

4.2.24 BWR Reactor Water Cleanup System (XI.M25)

4.2.24.1 Objective and Scope of Rev. 2 AMP XI.M25

The objective of this AMP is to manage the aging effects of cracking due to SCC or IGSCC on the intended function of austenitic SS piping outboard of the second primary containment isolation valves in the RWCU system. The components included in this program are the welds in piping that have a nominal diameter of 4 inches or larger and that contain reactor coolant at a temperature greater than 93°C (200°F) during power operation, regardless of code classification.

To ensure that potential detrimental effects of cracking would be adequately managed such that the intended function of the RWCU system is maintained during the PEO, the AMP relies on two AMAs:

(1) Inspection guidelines delineated in NUREG-0313, Rev. 2, and in GL 88-01 and its Supplement 1. GL 88-01 requested that affected licensees undertake ISI in accordance with the scope and schedules described in the letter and included affected portions of RWCU piping outboard of the second isolation valves in their ISI programs. However, in GL 88-01, Supplement 1, the staff noted affected licensees had requested that they be exempted from GL 88-01 with regard to inspection of this piping of the RWCU system because of the very high radiation levels associated with this portion of the piping.

    Based on the staff-approved screening criteria for the inspection (NRC letter dated Sept. 15, 1995), the staff has subsequently allowed individual licensees to modify their docketed responses to GL-88-01 to reduce or eliminate their ISI of RWCU welds in the piping outboard of the second isolation valves. The screening criteria include the following:
    (a) Satisfactory completion of all actions in GL 89-10;
    (b) No detection of IGSCC in RWCU welds inboard of the second isolation valves (ongoing inspection in accordance with the guidance in GL 88-01; and,
    (c) No detection of IGSCC in RWCU welds outboard of the second isolation valves after inspecting a minimum of 10% of the susceptible piping.

    The following inspection schedule is followed:
    Schedule A: No inspection is required for plants that meet all three criteria set forth above, or if they meet only criterion (a). Piping is made of material that is resistant to IGSCC, as described above in preventive actions.
    Schedule B: For plants that meet only criterion (a). Inspect at least 2% of the welds or two welds every refueling outage, whichever sample is larger.
    Schedule C: For plants that do not meet criterion (a). Inspect at least 10% of the welds every refueling outage.

(2) Mitigation measures to reduce the corrosion potential or the susceptibility for SCC or IGSCC by monitoring and control of reactor water chemistry based on the most recent NRC-approved industry guidelines. Currently, these guidelines for BWRs are contained in BWRVIP-190.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, Subsection IWB, Table IWB 2500-1;
(ii) GL 88-01, *NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping,* NRC, Jan. 25,

1988, and GL 88-01, Supplement 1, *NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping,* NRC, Feb. 4, 1992;
(iii) NUREG-0313, Rev. 2, *Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping,* W. S. Hazelton and W. H. Koo, NRC, 1988;
(iv) Letter from Joseph W. Shea, NRC, to George A. Hunger, Jr., PECO Energy Company, *Reactor Water Cleanup (RWCU) System Weld Inspections at Peach Bottom Atomic Power Station*, *Units 2 and 3*, Sept.15, 1995;
(v) GL 89-10, *Safety-related Motor Operated Valve Testing and Surveillance,* NRC, June 28, 1989, through Supplement 7, Jan. 24, 1996; and
(vi) BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines-2008 Revision*.

4.2.24.2 Observations from NMP-1

This AMP is not applicable to the Ginna because it is a PWR. The BWR Reactor Water Cleanup (RWCU) System Program of NMP-1 (B2.1.15) manages the effects of SCC and IGSCC to maintain the intended function of austenitic stainless steel piping in the RWCU system. This program is further detailed in the AEA TLR, ML13122A009.

The licensee's fourth 10-year interval ISI plan indicated that two non-safety, non-Code-class welds in the reactor water cleanup system experienced through-wall leakage. The inspection plan further indicated that these welds are located outboard of the primary containment isolation valves. In addition, SER Section 4.7.5.1 indicates that the leakage was due to IGSCC. The two non-safety welds were repaired using weld overlays (SER Section 4.7.5.1) and assigned to Category E. This classification is considered to provide reasonable assurance to manage the aging effect of the RWCU system outboard welds. The fourth interval inspection plan also indicated one weld out of the two welds was inspected within the first 6 years of the interval. The licensee indicated that no separate health report is generated for this program. However, the health report for the ASME ISI program includes the inspection activities for the welds included in the program scope of this AMP.

4.2.24.3 Effectiveness of AMP XI.M25 to Meet Its Objective

The audit report on the assessment of AMP effectiveness from the visit to NMP-1 was reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.24, "AMP Worksheet XI.M25 BWR Reactor Water Cleanup System." The significant conclusions related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.24.4.

4.2.24.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant conclusions from an assessment of the adequacy of the program description are as follows:

(a) The program description does not include the details related to the staff-approved screening criteria for the inspection of RWCU piping outboard of the second primary containment isolation valves.

(b) The program description does not clarify whether Code editions earlier than 1995 are acceptable, so that the licensees do not have to take an exception.

The AMPs implemented by NMP-1, and by several other license renewal applicants, have taken an exception from the GALL AMP XI.M25 related to the use of Code editions earlier than 1995. There were no good practices or strengths of the AMP identified in this review. In addition, information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.24.3.2 Effectiveness and Implementation of AMP XI.M25

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant conclusions from this evaluation are as follows:

(a) The scope of program (or program description) does not include the details related to the screening criteria and the inspection schedule recommended in this AMP. Such information would be needed to confirm consistent implementation of this AMP.

(b) The preventive action program element does not include specific guidance related to the use of NMCA for mitigation of SCC, IGSCC, or IASCC.

4.2.24.4 Recommendations for Subsequent License Renewal

4.2.24.4.1 Good Practices or Strengths of AMP XI.M25

No specific good practice was identified during the review.

4.2.24.4.2 Areas of AMP XI.M25 for Further Consideration/Enhancement

Program Description:

M24.0-1: *Recommendation*: Revise the program description to include the staff-approved screening criteria (NRC letter dated Sept. 15, 1995) for the inspection of austenitic SS piping outboard of the second primary containment isolation valves in the RWCU system.
***Technical Basis*:** Although the GALL, Rev. 2, AMP mentions the NRC screening criteria in the second sentence of the first paragraph of the program description, and again in the last sentence of the third paragraph, the detailed description of the criteria is contained in the middle of the description of Program Element 4 for detection of aging effects. Since the inspection guidelines recommended in this AMP are essentially based on the screening criteria, it would offer better clarity and usefulness to clearly describe the Staff-approved screening criteria either in the program description after the first paragraph, or in the scope of the program section, as was the case in GALL, Rev. 1.

M24.0-2: *Recommendation*: Revise the program description to clarify whether Code editions earlier than 1995 are acceptable, so that the licensees do not have to take an exception.
***Technical Basis*:** GL 88-01 recommends that inspection results be evaluated in accordance with the requirements of ASME Section XI, Subsection IWB-3640, whereas the GALL Reports

reference ASME Code editions only from 1995 to 2004 as modified and limited in 10 CFR 50.55a. Therefore, applicants have to justify the use of any other Code edition. It may be better clarified to revise the AMP to acknowledge that inspection requirements of earlier editions of the ASME Code Section XI are acceptable for the RWCU system.

1. <u>Scope of Program</u>:

M24.1-1: *Recommendation*: To confirm consistent implementation of the AMP, program description or scope of program may be revised to include the screening criteria and the inspection schedule recommended in this AMP.
***Technical Basis*:** At NMP-1, after meeting the three criteria for eliminating any further inspection, two RWCU system piping welds outboard of the second isolation valve were identified with pressure boundary leakage. Both welds were repaired by a full structural weld overlay, and reclassified to IGSCC Category E in accordance with GL 88-01. Since the identification of leakage from two of the outboard welds is considered a deviation from the previous compliance of the third criteria (no IGSCC in the outboard welds), in accordance with the recommendations of the GALL AMP the licensee should perform inspection of at least 2% of the welds or two welds, whichever is greater, on the portions of the RWCU system outboard of the second isolation valves every refueling outage. The licensee, however, is inspecting only one weld out of 30 welds during each refueling outage, which is not consistent with the GALL AMP XI.M25. Therefore, to ensure consistent implementation of the AMP it would be helpful if the program description or scope of program includes the screening criteria and the inspection schedule recommended in this AMP.

2. <u>Preventive Action</u>:

M24.2-1: *Recommendation*: Based on such information obtained from plants that have implemented NMCA, the preventive action program element may be updated to include specific guidance related to the use of NMCA for mitigation of SCC, IGSCC, or IASCC.
***Technical Basis*:** At NMP-1, the HWC/NMCA effectiveness is monitored by ECP probes installed in a reactor recirculation system flange and in the mitigation monitoring system (MMS) supplied from the RWCU system inlet line, and from catalytic loading (noble metal) measurements from MMS coupons. The NMCA system includes permanent monitoring equipment as well as connections for periodically injecting a noble metal solution. It draws a sample from the RWCU system, analyzes the effectiveness of the noble metal treatment in the durability monitor, and returns the sample to the RWCU system. Since NMP-1 was the first plant to implement NMCA, information regarding plant OpE during the initial period after NMCA was implemented would be very informative (particularly the effects of a higher concentration of iron or Co-60 in reactor water or deposits of Co-60 on surfaces or of zinc on fuel rods, etc.). Based on such information, the preventive action program element may be updated to include specific guidance related to the use of HWC and NMCA for mitigation of SCC or IGSCC in BWRs.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M24.4-1: *Recommendation*: To ensure consistent implementation of the AMP, the program description or scope of program may be revised to include the screening criteria and the

inspection schedule recommended in this AMP.
***Technical Basis*:** The extent and frequency of inspections recommended by the program are based on the condition of each weld (e.g., whether the welds were made from IGSCC-resistant material and whether a stress improvement process was applied to a weld to reduce the residual stresses, and how the weld was repaired if it had been cracked). At NMP-1, the fourth-interval ISI plan indicates that Category D welds, which are those welds not made with resistant materials and that have not been given an SI treatment, were examined and found to be free of cracks. The inspection plan also indicates that Category D includes all bimetallic nozzle welds made with non-resistant material and 182 Inconel weld butter. Therefore, in accordance with the recommendations of the GALL AMP, the licensee should perform inspections of at least 2% of the welds or two welds, whichever is greater, on the portions of the RWCU system outboard of the second isolation valves every refueling outage. The licensee, however, is inspecting only one weld out of 30 welds during each refueling outage, which is not consistent with the GALL AMP XI.M25. See recommendation M24.1-1 above for additional details.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M24.6-1: *Recommendation*: Update this program element to clarify whether Code editions earlier than 1995 are acceptable, so that the licensees do not have to take an exception.
***Technical Basis*:** The GL 88-01 recommends that any indication detected be evaluated in accordance with the requirements of ASME Section XI, Subsection IWB-3640, whereas the GALL Reports reference ASME Code editions from 1995 to 2004 as modified and limited in 10 CFR 50.55a. The applicant has to justify the use of any other Code edition. Therefore, most licensees, including NMP-1, take an exception to the GALL AMP and state that flaw indications are evaluated in accordance with IWB-3640 of the ASME Code Section XI, 1989 edition. For such cases where the guidance in the supporting document is based on an earlier edition of the ASME Code than what is referenced in the GALL Report, clarification may be provided on whether the earlier edition of the Code is acceptable, so that the applicants do not have to take an exception. See recommendation M24.0-2 above for additional details.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

No further review item identified.

4.2.25 Fire Protection (XI.M26)

4.2.25.1 Objective and Scope of Rev. 2 AMP XI.M26

The objective of this program is to provide AMAs for managing the aging effects in the fire protection systems and components that consist of fire barrier walls, ceilings, and floors, fire-rated doors and the halon/carbon dioxide (CO_2) fire suppression system. To ensure that the aging effects of the fire protections systems and components are managed in the PEO, the AMP relies on the following AMAs:

(1) Periodic visual inspection of fire barrier penetration seals, fire barrier walls, ceilings, and floors; and periodic visual inspection and functional tests of fire-rated doors to detect any sign of degradation, such as cracking, spalling, and loss of material caused by freeze-thaw, chemical attack, and reaction with aggregates that could affect their intended fire protection function.

(2) Periodic inspection and function testing of the halon/ CO_2 fire suppression system to examine for signs of corrosion that may lead to the loss of material of the halon/CO_2 fire suppression system. The periodic functional test is performed at least once every 6 months or on a schedule in accordance with an NRC-approved fire protection program.

(3) The results of inspections of the aging effects of cracking, spalling, and loss of material on fire barrier penetration seals, fire barriers, and fire doors are used to trend future actions. The performance of the halon/CO_2 fire suppression system is monitored during the periodic test to detect any degradation in the system. These periodic tests provide data necessary for trending.

(4) NRC IN 88-56, IN 94-28, and IN 97-70 provide OpE related to degradation of silicone foam fire barrier penetration seals. NRC IN 91-47 and GL 92-08 provide OpE of degradation of electrical raceway fire barrier and fire doors experienced wear of the hinges and handles.

10 CFR 50 Appendix R, “Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979” provides a basis for plant fire protection programs.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) 10 CFR 50 Appendix R; and
(ii) NRC IN 88-56, IN 94-28, IN 97-70, IN 91-47, and GL 92-08.

4.2.25.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.13, “Fire Protection.” Trending reports and system health reports for the Ginna FP AMP are prepared on a quarterly basis. Trending reports were analyzed during the audit; it does not appear that there are a significant number of condition reports since 2008. Only three were related to the FP program, and they were all at a low category of concern. Further details are available in the AEA TLR, ML13122A009.

Aging effects and aging mechanisms of fire break and fire wrap are identified in the Ginna AMP. Visual inspections of fire doors and verification of clearances are performed on a quarterly basis, and not bimonthly as stated in the GALL Report. A review of Ginna quarterly fire door walkdown operating experience indicated that these issues have not been of concern.

During the AMP audit interview, Ginna FP AMP program owners confirmed that Ginna is continuing to test the diesel-driven fire pumps. It was reported that impeller wear of the electric motor-driven fire pump has been observed at Ginna.

NMP-1 implements AMP XI.M26, "Fire Protection," through its existing AMP B2.1.16, "Fire Protection Program." Further details are available in ML13122A009.

The NMP-1 FP AMP owners pointed out that some fire barrier penetration seals (i.e., silicone foam, elastomer, Kaowool, and flamastic) were damaged. Flamastic sealant, when subjected to vibration and thermal cycling, can become brittle and after heating can swell and crack. Routine inspection of these penetrations has been performed adequately to ensure that defects are repaired prior to loss of functionality.

In the July–September 2011 "Fire Detection and Fire Suppression System Health Report," NMP-1 determined that performance of fire protection and fire water systems was unacceptable in this period. The report stated that critical issues include:

- Degradation of CO_2 system
- Poor reliability of fire panels, detection systems, and Drazetz recorder
- Diesel fire pump (DFP) piston ring wear margins issues
- Smoke removal dampers with failure rates due to binding; NMP-1 stated that dampers are a Safe Air Model 700 that are obsolete and have a history of repetitive failures (bindings); NMP-1 plans to upgrade the dampers to a new design

NMP-1 pointed out that aging and obsolescence are issues for the fire panels, and the dampers failing to stroke was most likely caused by age-related degradation of the damper actuators. All of the dampers are early 1980 vintage equipment. In CR-2005-001483, smoke removal dampers were observed to not open under any circumstances. The licensee later provided the following clarifying insight into the four items listed above, detailed in ML13122A009.

4.2.25.3 Effectiveness of AMP XI.M26 to Meet Its Objective

The NRC audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.25, "AMP Worksheet XI.M26 Fire Protection." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.25.4.

4.2.25.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) NMP-1 is in transition from the deterministic-based 10 CFR Part 50 Appendix R fire protection to the risk-based NFPA 805. The NFPA 805 risk-based fire protection has been endorsed by NRC and some plants have already transitioned to the NFPA 805 fire protection program. The program description does not include plant fire protection programs based on the risked-based NFPA 805, which may have impacts on the fire protection AMP regarding intervals of inspection and testing and locations for inspection.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with GALL, AMP XI.M26

The NMP-1 Fire Protection Program takes an exception to the GALL Report "Detection of Aging Effects" program element where it requires bi-monthly inspection of hollow metal fire doors and monthly inspection of the halon/carbon dioxide suppression system valve lineup. Staff reviewed the exceptions in the SER and found these exceptions are acceptable because NMP-1 followed the guidelines in ISG-04 “Aging Management of Fire Protection Systems for License Renewal" on both exceptions.

NMP-1 has the following commitments in SER Appendix A prior to the PEO:

(1) Incorporate periodic visual inspections of piping and fittings in a non-water environment (e.g., halon) and CO_2 fire suppression systems components to detect evidence of corrosion and any system mechanical damage that could affect its intended function.

(2) Expand the scope of periodic functional tests of the diesel-driven fire pump to include inspection of engine exhaust system components to verify that loss of material is managed.

(3) Perform an engineering evaluation to determine the plant-specific inspection frequency of fire doors.

(4) Revise Halon and CO_2 functional test frequencies to semi-annual.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.25.3.2 Effectiveness and Implementation of AMP XI.M26

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The Ginna Fire Protection AMP includes aging management of fire break, fire wraps and grout. These items are passive components that are not included in the GALL Report.

(b) The Ginna Fire Protection AMP includes diesel-driven fire pump performance test that is not included in GALL, Rev. 2.

4.2.25.4 Recommendations for Subsequent License Renewal

4.2.25.4.1 Good Practices or Strengths of AMP XI.M26

M25.S-1: *Recommendation*: A trending report should be prepared on a quarterly basis.
Technical Basis: Trending reports and system health reports of the Ginna Fire Protection AMP are available at Ginna on a quarterly basis. Quarterly trending is considered a good practice and should be recommended in GALL generically.

4.2.25.4.2 Areas of AMP XI.M26 for Further Consideration/Enhancement

<u>Program Description</u>:

M25.0-1: *Recommendation*: Expand the GALL AMP program description to include aging management of fire break, fire wrap, and fire pump performance tests.
***Technical Basis*:** The Ginna Fire Protection AMP includes aging management of the fire break, fire wrap, and fire pump performance tests.

M25.0-2: *Recommendation*: Expand the program description to include a plant fire protection program based on the risked-based NFPA 805. This may impact intervals of inspection and testing and other factors (e.g., locations for inspections).
***Technical Basis*:** NMP-1 is in transition from deterministic-based 10 CFR Part 50 Appendix R fire protection to the risk-based NFPA 805. The NFPA 805 risk-based fire protection has been endorsed by NRC and some plants have already transitioned to the NFPA 805 fire protection program. As for the subsequent license renewal, more plants will adopt the NFPA 805 risk-based fire protection.

1. <u>Scope of Program</u>:

M25.1-1: *Recommendation*: Include fire break (fire stop), fire wraps, and concrete grout in the scope of program. Add essential information regarding the IEEE-383 test method to measure the flame resistance of wire and cable products.
Technical Basis: The Ginna Fire Protection AMP includes aging management of fire break (fire stop), fire wraps, and concrete grout. These items are passive components that are not included in the GALL Report. The fire break (fire stop) limits flame propagation along vertical or horizontal cable tray runs and the fire wrap is heat resistant covering (Hymec Wrap) to protect safe shutdown circuits. They are important fire protection components.
The flame resistance of a cable is frequently defined as the ability to stop burning once the source of heat is removed. Test methods such as IEEE-383 have been developed to measure the flame resistance of wire and cable products (add IEEE-383 in reference).

M25.1-2: *Recommendation*: The Ginna Fire Protection AMP includes periodic testing of fire pumps.

The Ginna AMP states, “Periodic testing of the motor and diesel-driven fire pumps ensures that adequate flow of firewater is supplied and that there is no degradation of diesel fuel lines to the diesel fire pump,” and, “Two redundant, full capacity fire pumps, one electric-motor driven and one diesel driven, with independent power supplies and controls are provided. The fuel supply tank for the diesel driven fire pump contains an eight hour minimum fuel supply.”

The Ginna STP-O-13 states, “Performance test is performed monthly to verify the standby operability of the diesel engine-driven and electric motor-drive fire pumps,” and, “Periodic testing of the fire pumps provided data and trending to justify replacement of Diesel fire pump engine in 1994 and replacement of both pump assemblies in 2002 and 2003 to address wear-related impeller and column pipe issue.”

Based on these statements, subsequent license renewal AMPs should recommend the following:

(a) Put back the periodic diesel fire pump performance testing in the GALL Report. Fuel oil analysis and one-time inspection cannot assure that an “adequate” flow of water is supplied, and they cannot detect aging effects such as wear of impellers, which resulted in replacement of the diesel fire pump in 1994 and pump assemblies (both diesel and electric-motor driven pump) in 2002 and 2003. Since wear of the impeller of electric-motor driven fire pumps also occurred, periodic testing of the electric fire pump should also be included in the AMP.

During the AMP audit interview, Ginna FP AMP program owners confirmed that Ginna is still continuing to test the fire pumps (along with pump oil collection tank RCPs); it is their opinion that the test results suggest that it is necessary to include testing of the fire pumps in the subsequent renewal.

(b) Add “diesel fuel tanks” in the AMR table. The GALL Report has only one line item for piping, piping components, and piping elements in the fuel oil environment. It does not include diesel fuel oil tanks.

Technical Basis: The Ginna Fire Protection AMP includes a diesel-driven fire pump performance test that is not included in GALL, Rev. 2.

Diesel-driven fire pump performance test and inspection of the fuel oil supply line were deleted from the scope of the Fire Protection AMP of GALL, Rev. 2, because the diesel-driven fire pump fuel oil supply line is managed by the Fuel Oil Analysis and the One-Time Inspection Programs accepted by NRC staff in numerous LR SERs (NUREG-1950).

M25.1-3: *Recommendation*: Include loss of material due to corrosion of fire pump exhaust system components in the fire protection AMR Table and the AMP.
Technical Basis: NMP-1 has the following commitments in SER Appendix A prior to the PEO. Inspection of engine exhaust system components for loss of material is one of the commitments.

(a) Incorporate periodic visual inspections of piping and fittings in a non-water environment (e.g., halon), as well as CO_2 fire suppression systems components, to detect evidence of corrosion and any system mechanical damage that could affect its intended function.

(b) Expand the scope of periodic functional tests of the diesel-driven fire pump to include inspection of engine exhaust system components to verify that loss of material is managed.

(c) Perform an engineering evaluation to determine the plant-specific inspection frequency of fire doors.

(d) Revise Halon and CO_2 functional test frequencies to semi-annual.

M25.1-4: *Recommendation*: Add Fire Protection Pump House in the Group 3 Structures of GALL Section III, "Structures and Components Supports."
Technical Basis: The structure that houses the fire protection pumps is not included in the GALL, even though it does not appear to be covered by the maintenance rule and it therefore within the scope of license renewal.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

M25.3-1: *Recommendation*: Expand materials and aging effects requiring management (AERM) AMR line items; at Ginna, a significant number of those (e.g., fire stops and fire wraps) were not included in GALL 2001 or GALL 2010.

- Fire stop material (indoor no air conditioning).
    - Cracking/delamination due to movement, shrinkage, and vibration.
    - Hardening and shrinkage due to weathering.
    - Loss of material.
    - Separation due to movement.
    - Separation due to shrinkage.
    - Separation due to vibration.
- Fire wrap material (indoor, no air conditioning).
    - Cracking/delamination due to movement.
    - Cracking/delamination due to vibration.
    - Loss of material.
- Concrete grout (indoor, no air conditioning).
    - Cracking/delamination due to movement.
    - Cracking/delamination due to shrinkage.
    - Cracking/delamination due to vibration.
    - Hardening and shrinkage due to weathering.
    - Loss of material/separation due to movement.
    - Separation due to shrinkage.

Structural SS (indoor, no air conditioning): No aging effect.

Technical Basis: The Ginna Fire Protection AMP includes aging management of fire stops, fire wraps and concrete grout and their aging mechanisms. However, these items are passive components, and are not included in the GALL Report.

4. <u>Detection of Aging Effects</u>

M25.4-1: *Recommendation*: Expand the program element to include NFPA 805 in the NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program) and provide guidelines in the AMP based on NFPA 805 and RGs related to NFPA 805, such as the following:

RG 1.205, Rev. 1, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," Dec. 2009.

RG 1.189 "Fire Protection for Nuclear Power Plants," October 2009.

Fire protection based on NFPA 805 may have significant impacts on inspection scope and inspection frequencies on the fire protection aging management.

Technical Basis: The GALL Report states that visual inspection of seals is performed at a frequency in accordance with an NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program), or at least once every refueling outage.

The GALL Report also states that the periodic functional test of halon/CO_2 fire suppression system is performed at least once every 6 months or on a schedule in accordance with an NRC-approved fire protection program.

NMP-1 is in transition from the deterministic-based Appendix R program to the risk-based NFPA 805 program. The Risk-Informed, Performance-Based Fire Protection based on NFPA 805 has been endorsed by NRC and some plants have already completed the transition. The GALL Report, however, has not taken into consideration of the risk-based NFPA 805 program.

5. <u>Monitoring and Trending</u>:

M25.5-1: *Recommendation*: The GALL program element should emphasize importance of trending and recommend preparing a trending report on a quarterly basis.
Technical Basis: A trending report and system health report of the Ginna Fire Protection AMP are available at Ginna on a quarterly basis. The quarterly trending is considered to be a good practice and should be recommended in the GALL Report. (Note: One area that can be improved in the Ginna trending and health report is to differentiate whether "no problem found in this period" is based on inspection results or because no inspection was conducted in this quarterly period.)
NMP-1 does not perform trending and has no trending report. This is a shortcoming of the NMP-1 Fire Protection Plan. The GALL Report should emphasize the importance of trending.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M25.10-1: *Recommendation*: EPU could have significant impacts on various auxiliary systems (e.g., adding additional safety equipment to account for the effects of increased decay heat due to power upgrade). EPU may affect the plant fire protection systems. The GALL Report may request the applicant to address the effects of power upgrade on aging management of the fire

protection systems in OpE.
Technical Basis: Additional equipment was added to the list of safe-shutdown components in Ginna to account for the effects of increased decay heat due to power upgrade. However, there was no impact from EPU on the Ginna Fire Protection Program, and the program will continue to meet the requirements of 10 CFR 50.48, Appendix R, to 10 CFR Part 50, and GDCs 3 and 5 following implementation of the proposed EPU.

4.2.26 Fire Water System (XI.M27)

4.2.26.1 Objective and Scope of Rev. 2 AMP XI.M27

The objective of this program is to provide AMAs for managing the aging effects in the water-based fire protection systems that consist of sprinklers, nozzles, fittings, valves, fire pump casings, hydrants, hose stations, standpipes, water storage tanks, and aboveground, buried, and underground piping and components. To ensure that the aging effects are managed in the PEO, the AMP relies on the following AMAs:

(1) The water-based fire protection systems are tested in accordance with the applicable NFPA codes and standards to assure the minimum functionality of the systems.

(2) A sample of sprinkler heads is tested by using the guidance of NFPA 25, "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems" (1998 Edition), Section 2-3.1.1, or NFPA 25 (2002 Edition), Section 5.3.1.1.1.

(3) The water-based fire protection system piping is subjected to required flow testing in accordance with guidance in NFPA 25 to verify design pressure or evaluated for wall thickness (e.g., non-intrusive volumetric testing or plant maintenance visual inspections) to ensure that aging effects are managed and that wall thickness is within acceptable limits.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) NFPA 25 1998 and 2001 editions.

4.2.26.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.14 "Fire Water System." Further details are available in the AEA TLR, ML13122A009.

Ginna performs 3-year inspections on fire water storage tanks. During the 2004 inspection, 32 areas of coating failures were found in the interior of the fire storage water tank. There are 16 FWS-related CRs from 2008 to 2010 in the trending documents. Most of the CRs relate to excessive corrosion on fire piping, valves, vent, drain, and bolts, and selective leaching of valves. The corrective actions for CR-2009-003214 included adding inspection results to the FWS corrosion-monitoring program for tracking periodic fire water piping inspections.

Generally, aging effects were found by this AMP and were documented in the CRs.

NMP-1 implements this program through its existing AMP B2.1.17, "Fire Water System Program." Further details are available in ML13122A009.

It was noted during the NMP-1 audit that tuberculation was observed in fire water branch piping during the flow tests. The staff noted that the tuberculation found in the NMP-1 FWS appears to be an aging effect that should be considered for inclusion in potential SLR guidance documents, as it was not included in Revisions 0, 1, or 2 of the LRGDs. The licensee indicated that there are repetitive observations of tuberculation and that this is an ongoing issue. (Following the audits at Ginna and NMP-1, NRC staff issued a draft LR-ISG (LR-ISG-2012-02) related to internal surfaces and corrosion under insulation that suggested revisions to AMPs XI.M27, XI.M29, XI.M36, XI.M38, XI.M42 and included tuberculation as an aging effect.) Other than tuberculation, degradation reported in CRs in recent years includes:

- Obstructions in fire water piping due to corrosion products or lake water silt (one CR in 2005)
- Through-wall leaks of fire protection piping (4 CRs in 2002-2004)
- UT readings of fire protection piping below minimum wall thickness (7 CRs)

In the fire water pressure maintenance subsystem, which pumps oxygenated city water, NMP-1 replaced CS piping with stainless steel (SS), and the diameter of the SS piping was increased. The previously 1.5-in. diameter CS piping was replaced with 2-in. SS piping.

4.2.26.3 Effectiveness of AMP XI.M27 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.26, "AMP Worksheet XI.M27 Fire Water System." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.27.4.

4.2.26.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) As mentioned in the program description, Chapter XI.M41 describes the AMP for buried and underground water-based fire protection system piping and tanks. However, the GALL XI.M41 program does not address selective leaching (i.e., graphitization of cast iron piping and components in wet acidic soil) of the buried fire-water systems that might occur. For SLR, the program description should also state that the GALL XI.M33 "Selective Leaching of Materials" program should be used in addition to XI.M41 for applicable materials and environments.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GAL, AMP XI.M27.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.26.3.2 Effectiveness and Implementation of AMP XI.M27

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL AMP states that this AMP manages loss of material due to corrosion, MIC, or biofouling of steel components in the fire protection system exposed to water. It is not clear how the aging degradation is managed for components in the fire water system that are made of other materials such as brass, cement, or PVC. A statement in the scope of program or program description may be helpful.

A large fraction of the fire water system is normally dry and not exposed to indoor or outdoor air. The yard nozzles are normally open and the dry piping between the nozzles and the supply valve collect dust or other pollutants. These lines get wet when flow tested, which can cause corrosion. As written, XI.M27 seems to suggest that only the system exposed to water is covered by the program. There should be clear guidance regarding the aging management of the normally dry portions of the fire water system.

4.2.26.4 Recommendations for Subsequent License Renewal

4.2.26.4.1 Good Practices or Strengths of AMP XI.M27

M26.S-1: *Recommendation*: NMP-1 is committed to implementing the following commitment prior to the PEO: "Establish an appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and volumetric testing." This is considered a good practice is recommended for all the AMPs generically.
***Technical Basis*:** The results of such practice provide a basis for continued improvement of program effectiveness.

4.2.26.4.2 Areas of AMP XI.M27 for Further Consideration/Enhancement

<u>Program Description</u>:

M26.0-1: *Recommendation*: Add the following statements for plants using raw water such as lake- or seawater as a water source (as opposed to city water): "For plants using raw water (e.g., lake- or seawater as a water source), the program consists of periodic sampling and analysis of water systems for the presence of bacteria and microbiological contamination."
***Technical Basis*:** SER 3.3 B.2.3.13: Site procedure S-CTP-V632, "Sampling and Analysis of Water Systems for Bacteria," is credited with managing loss of material due to microbiological activity. The procedure provides for sampling and analysis of raw water systems for the presence of bacteria. In addition, as presented in Sections A1.1.18 and B2.1.17 of the original LRA, the Fire Water System Program will be enhanced prior to the PEO to add specific requirements for periodic sampling of water-based fire protection systems. The GALL AMP needs to include periodic sampling and analysis for the presence of bacteria in the fire water systems using raw water as a water source.

M26.0-2: *Recommendation*: Change the AMR line item VII.G.A-33 to the following: "piping, piping components, piping elements, and <u>water storage tanks</u>."
***Technical Basis*:** The program description mentions water storage tanks; however, the AMR line item VII.G.A-33 only contains "piping, piping components, and piping systems" in an environment of raw water. It does not include water storage tanks. Ginna performs 3-year inspections on fire water storage tanks. During the 2004 inspection, 32 areas of coating failures were found in the interior of the fire storage water tank. Water storage tanks need to be included in the program.

M26.0-3: *Recommendation*: Expand the program description as follows: "Chapter XI.M41 describes the AMP for buried and underground water-based fire protection system piping and tanks. Selective leaching (i.e., graphitization of cast iron piping and components in wet acidic soil) of the buried fire-water systems could occur in wet acidic soil. The Chapter XI.M33, "Selective Leaching of Materials," program should be also used in addition to XI.M41 for aging management of buried fire water systems."
***Technical Basis*:** As mentioned in the program description, Chapter XI.M41 describes the AMP for buried and underground water-based fire protection system piping and tanks. However, the GALL XI.M41 program does not address selective leaching (i.e., graphitization of cast iron piping and components in wet acidic soil) of the buried fire-water systems that could occur. For SLR, the program description should also state that the GALL XI.M33, "Selective Leaching of Materials," program should be used in addition to XI.M41 for applicable materials and environments.

1. Scope of Program:

M26.1-1: *Recommendation*: Add guidance on aging management of fire water systems that are made of other materials (e.g., brass, cement, or PVC) and the normally dry portions of the fire water system (e.g., yard nozzle and dry piping).
Technical Basis: The GALL AMP states that this AMP manages loss of material due to corrosion, MIC, or biofouling of steel components in the fire protection system that have been exposed to water. It is not clear how aging degradation is managed for components in the fire water system that are made of other materials, such as brass or cement or PVC. A statement in the scope of program or program description may be helpful.
A large fraction of the fire water system is normally dry and not exposed to indoor or outdoor air. The yard nozzles are normally open and the dry piping between the nozzles and the supply valve collect dust or other pollutants. These lines get wet when flow tested, which can cause corrosion. As written, XI.M27 seems to suggest that only the system exposed to water is covered by the program. There should be clear guidance regarding the aging management of the normally dry portions of the fire water system.

M26.1-2: *Recommendation*: Add guidance on aging management of fire water systems that are made of other materials (e.g., brass, cement, or PVC) and the normally dry portions of the fire water system (e.g., yard nozzle and dry piping).
Technical Basis: Ginna is committed to implementing the following commitment prior to the PEO in the SER, Appendix A: "Add fire service water (SW) booster pump and associated valves and piping back to the SW system into the scope of license renewal."

2. Preventive Action:

M26.3-1: *Recommendation*: Replace CS piping with SS piping and increase piping size to prevent corrosion and bio-fouling.
Technical Basis: NMP-1 replaced CS piping with SS, and the diameter of the SS piping was increased. What was previously 1.5-in.-diameter CS piping was replaced with 2-in. SS piping. Replacing the CS piping with SS piping and increasing the diameter can be considered preventive measures.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects

M26.4-1: *Recommendation*: Add the following statement: "Periodic sampling and analysis of the raw-water-based fire protection systems is performed to check for the presence of bacteria and microbiological contamination."
Technical Basis: NMP-1 is committed to implementing the following commitment prior to the PEO: "Add requirements to periodically check the water-based fire protection systems for microbiological contamination." The GALL AMP needs to include this requirement for fire water systems using raw water.

5. Monitoring and Trending:

M26.5-1: *Recommendation*: The GALL program element states, "Degradation identified by non-intrusive or visual inspection is evaluated." Change the statement to "Degradation identified by non-intrusive or visual inspection is evaluated and trended." The following statement should also be added: "An appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and volumetric testing is established before extended period of operation. This is a good practice and is recommended for all the AMPs generically.
Technical Basis: NMP-1 is committed to implementing the following commitment prior to the PEO: "Establish an appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and volumetric testing." This is considered as a good practice.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

M26.10-1: *Recommendation*: Add the Ginna and NMP-1 CR cases in the OpE. Address tuberculation in the AMP. Tuberculation is a degradation condition that develops on the interior of pipelines due to corrosive materials that are present in the water passing through the pipe and results in the creation of small, more or less hemispherical lumps (tubercules) on the walls of the pipe, which increase friction loss and reduce flow velocity.
Technical Basis: The GALL program element does not contain an example of the degradation of fire water systems. Ginna performs 3-year inspections on fire water storage tanks. During the 2004 inspection, 32 areas of coating failures were found in the interior of the fire storage water tank.

The CR of NMP-1 includes the following:

- Obstructions in fire water piping due to corrosion products or lake water silt (one CR in 2005).
- Through-wall leaks of fire protection piping (4 CRs in 2002-2004).
- UT readings of fire protection piping below minimum wall thickness (7 CRs).
- Tuberculation has been observed in branch piping in the flow tests.

M26.10-2: *Recommendation*: Add tuberculation due to MIC as an aging mechanism in the fire water piping and add Victaulic seals and associated components in the AMR table. Add aging management of tuberculation and Victaulic seals in the AMP program elements as appropriate. ***Technical Basis:*** NMP-1 engineers believe that the life of Victaulic joints may be the major issue of the fire water system for subsequent renewal. Therefore, Victaulic seals in the AMR table is recommended. Tuberculation has been observed in branch piping in the NMP-1 flow tests and is a credible aging mechanism. Currently in NUREG-1801, Rev. 2, only 5 out of 1520 AMR line items are based on XI.M27. Based on OpE with tuberculation and Victaulic seals, these items may need additional focus.

4.2.27 Above Ground Metallic Tanks (XI.M29)

4.2.27.1 Objective and Scope of Rev. 2 AMP XI.M29

The objective of this program is to provide AMAs for managing the effects of loss of material on the outer surfaces of above ground metallic tanks constructed on concrete or soil. To ensure the aging effects are managed such that the intended functions of the above ground metallic tanks are maintained in the PEO, the AMP relies on the following AMAs:

(1) Performing periodic visual inspection of external surfaces of the above ground metallic tanks.

(2) Performing periodic inspections to monitor degradation of the protective paint or coating.

(3) Measuring the thickness of the tank bottom surface to ensure that significant degradation in inaccessible locations is not occurring.

4.2.27.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.1, "Aboveground Carbon Steel Tanks." The program consists of periodic visual examination by system engineers and a one-time limited UT examination of the tank bottoms. The AMP was written to conform to Revision 0 of the GALL Report and does not meet the guidance of AMP XI.M29 of the GALL Report, Rev. 2, which recommends follow-up UT every 5 years. Ginna performed a one-time limited UT inspection of the tank bottoms prior to the PEO in 2004 as indicated in the SER and LRA. It was noted during the audit that the AMP and associated implementing procedures do not address any follow-up examination of the tank bottom plates, even though a one-time inspection of the tanks in 2004, prior to the PEO, indicated loss of thickness of up to 20 percent due to corrosion. However, the wall loss observed was due to failed coatings on the accessible internal surfaces and was found during visual inspections. This internal coating has not been repaired. A UT examination of the tank bottom indicated that the outer surface (e.g., the underside, inaccessible area of the tank bottom where it is in contact with the concrete pedestal) is not displaying aging degradation. The tank bottom plates were not repaired or coated at that time, and no follow-up inspections were scheduled. The AMP owner stated that they are now scheduling follow-up UT inspections every 6 years.

At Ginna, the exterior surfaces of the tanks are periodically visually inspected by the system engineers. However, it was noted that no special training or qualification is required to conduct this inspection.

GALL Report AMP XI.M29, "Aboveground Carbon Steel Tanks," is not applicable to NMP-1. NMP-1 credits the existing plant-specific programs, AMP B2.1.32, "Preventive Maintenance Program," and AMP B2.1.33, "System Walkdown Program," for managing aging effects of aboveground metallic tanks. Further details are available in the AEA TLR, ML13122A009. The audit found that the overall program appears to provide a reasonable framework for managing aging in the SSCs to which it is applied.

The Systems Walkdown Program at NMP-1 manages aging effects for accessible external surfaces of selected SSCs within the scope of license renewal. The specific aging effect of concern is loss of material from external surfaces of pumps, valves, piping, bolts, heat exchangers, tanks, expansion joints, electrical penetrations, electrical enclosures and cabinets, HVAC components, and other carbon steel components. Program activities include system

engineer walkdowns (i.e., field evaluations of system components to assess system performance and material condition), evaluation of inspection results, and appropriate corrective actions. The frequency of inspections is at least once per refuel cycle for each structure and system.

4.2.27.3 Effectiveness of AMP XI.M29 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.27, "AMP Worksheet XI.M29 Above-Ground Metallic Tanks." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.27.4.

4.2.27.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

This program is not specifically used for aging management at Ginna Station. Inspection, testing, and surveillance activities of above-ground tanks are performed at Ginna Station through the Systems Monitoring Program and One-Time Inspection Program.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR. This may be considered an important aspect and may be pursued in future efforts.

4.2.27.3.2 Effectiveness and Implementation of AMP XI.M29

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant conclusions from the evaluation are as follows:

(a) The GALL program element states that potential corrosion of tank bottoms is determined by taking UT thickness measurements of the tank bottoms whenever the tank is drained and at least once within 5 years of entering the PEO. An one-time inspection of UT measurement prior to the PEO at Ginna found significant loss of thickness at tank bottom due to corrosion; however, no follow-up examinations are scheduled.

4.2.27.4 Recommendations for Subsequent License Renewal

4.2.27.4.1 Good Practices or Strengths of AMP XI.M29

No specific good practice was identified during the review.

4.2.27.4.2 Areas of AMP XI.M29 for Further Consideration/Enhancement

Program Description:

No further review item identified

1. Scope of Program:

No further review item identified

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M27.4-1: ***Recommendation*:** Add a statement that inspections of the tanks should be conducted by structural engineers qualified to monitor structures and components for applicable aging effects, or inspectors qualified in accordance with ASME code for VT1 and VT3 examinations.
Technical Basis: The Ginna AMP staff audit report indicates that AMP XI.M29 should include a statement that inspections of the tanks should be conducted by structural engineers qualified to monitor structures and components for applicable aging effects, or inspectors qualified in accordance with ASME code for VT1 and VT3 examinations.

M27.4-2: ***Recommendation*:** Add a statement that for tank bottoms with significant corrosion found, more frequent thickness measurements may be required within 5 years.
***Technical Basis*:** The Ginna AMP staff audit report indicates an one-time inspection of UT measurement prior to the PEO at Ginna found significant loss of thickness at tank bottom due to corrosion; however, no follow-up examinations are scheduled.
The GALL program element states that potential corrosion of tank bottoms is determined by taking UT thickness measurements of the tank bottoms whenever the tank is drained and at least once within 5 years of entering the PEO.
For tank bottoms with significant corrosion more frequent thickness measurements may be required within 5 years to ensure degradation can be detected in a timely manner.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.28 Fuel Oil Chemistry (XI.M30)

4.2.28.1 Objective and Scope of Rev. 2 AMP XI.M30

The program includes (a) surveillance and maintenance procedures to mitigate corrosion and (b) measures to verify the effectiveness of the mitigative actions and confirm the insignificance of an aging effect. Fuel oil quality is maintained by monitoring and controlling fuel oil contamination in accordance with the plant's technical specifications. Guidelines of the ASTM Standards, such as ASTM D 0975-04, D 1796- 97, D 2276-00, D 2709-96, D 6217-98, and D 4057-95, also may be used. Exposure to fuel oil contaminants, such as water and microbiological organisms, is minimized by periodic draining or cleaning of tanks and by verifying the quality of new oil before its introduction into the storage tanks. However, corrosion may occur at locations in which contaminants may accumulate, such as tank bottoms. Accordingly, the effectiveness of the program is verified to ensure that significant degradation is not occurring and that the component's intended function is maintained during the PEO. Thickness measurement of tank bottom surfaces is an acceptable verification program.

The fuel oil chemistry program is generally effective in removing impurities from intermediate- and high-flow areas. This report identifies those circumstances in which the fuel oil chemistry program is to be augmented to manage the effects of aging for license renewal. For example, the fuel oil chemistry program may not be effective in low-flow or stagnant-flow areas. Accordingly, in certain cases as identified in this report, verification of the effectiveness of the chemistry program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the PEO. As discussed in this report for these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) ASTM D 0975-04, *Standard Specification for Diesel Fuel Oils*, 2004;
(ii) ASTM D 1796-97,*Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method*, 1997;
(iii) ASTM D 2276-00,*Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling,* 2000;
(iv) ASTM D 2709-96,*Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge*, 1996;
(v) ASTM D 4057-95, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*, 2000; and
(vi) ASTM D 6217-98, *Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration*, 1998.

4.2.28.2 Observations from Ginna and NMP-1

This program is implemented at Ginna through AMP B2.1.16, "Fuel Oil Chemistry." Further details are available in the AEA TLR, ML13122A009.

The licensee later provided information that the tank draining, cleaning and inspecting tasks are included in the Preventive Maintenance Program Repetitive Tasks program and are performed every 9 years (six refueling outages), including supplemental ultrasonic examination (measurement of wall thickness) of locations where contaminants might accumulate, such as tank bottoms. No biological activity or evidence of degradation of the interior surfaces of either storage tank has been observed.

NMP-1 implements this program through its AMP B2.1.18, “Fuel Oil Chemistry Program.” Further details are available in ML13122A009.

The NMP-1 LRA states that a review of plant-specific OpE revealed several incidents where contaminants (e.g., water, particulate) were detected through Fuel Oil Chemistry Program examinations. Numerous water and sediment analyses performed over a long operating period detected conditions that did not meet plant specifications. In each case, appropriate actions were taken. These actions included increased monitoring, backup samples, contamination removal, and tank cleaning. However, there have been no instances of fuel oil system component failures at NMP-1 attributed to contamination.

During the AMP audit, NMP-1 personnel stated that two UT inspections of the fuel oil tanks found regions where the local thickness due to pitting was less than the acceptance criterion of 0.3125 inches, and engineering evaluations were performed to verify the structural integrity of the tank. It was determined that the affected tank did not require repair or replacement.

4.2.28.3 Effectiveness of AMP XI.M30 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.28, “AMP Worksheet XI.M30 Fuel Oil Chemistry.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.28.4.

4.2.28.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description states that “the effectiveness of the program is verified to ensure that significant degradation is not occurring and that the component’s intended function is maintained during the period of extended operation. Thickness measurement of tank bottom surfaces is an acceptable verification program.” However, the AMP provides no further guidance on acceptable methods for determining the thickness of the fuel oil tank bottom or on acceptance criteria. Two UT inspections of the fuel oil tanks performed at NMP found regions where the local thickness was less than the acceptance criteria, and engineering evaluations were performed to verify the structural integrity of the tank. An industry standard or some other guidance is desirable to address tank bottom thickness determinations and acceptance criteria in more detail.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M30, with some exceptions and enhancements. The Ginna Fuel Oil Chemistry AMP lists no enhancements to

GALL, Rev. 0, but lists two exceptions, namely Ginna (1) does not add biocides, stabilizers, or corrosion inhibitors to the fuel oil to mitigate corrosion; and (2) does not sample for particles in accordance with the modified ASTM D2276 test procedure. NMP takes the following exceptions to GALL, Rev. 0: (1) NMP-1 and NMP-2 use only the guidance given in ASTM D1796 rather than in both ASTM D 1796 and ASTM D2709 to determine the concentration of water and sediment in the diesel fuel oil tanks (these standards are applicable to fuel oils of different viscosities, and ASTM D 1796 is the standard that applies to the diesel fuel used at NMP-1 and NMP-2); (2) NMP-1 and NMP-2 take an exception to using the modified ASTM D 2276, Method A, which specifies a pore size of 3.0 µm, and NMP-1 and NMP-2 use a filter with a pore size of 0.8 µm, as specified in ASTM D 2276; (3) NMP-1 and NMP-2 take an exception to multilevel sampling in the diesel fuel oil tanks (the physical configuration of the fuel oil tanks does not allow a representative fuel oil sample to be taken at multiple levels); and (4) NMP-1 and NMP-2 take an exception to periodically sampling the diesel fuel oil day tanks. These small tanks do not have a provision for sampling. Per Technical Specification Surveillance testing, the lower portion of the diesel fuel oil is drained quarterly in NMP-1, and monthly in NMP-2.

In addition, the following enhancements are noted: (1) incorporate periodic tests for microbiological organisms at NMP-1; (2) provide guidelines for the appropriate use of biocides, corrosion inhibitors, and/or fuel stabilizers to maintain fuel oil quality; (3) add a requirement to sample the NMP-2 diesel fuel oil storage tanks for water and sediment at least quarterly per the ASTM standard; (4) add requirements to periodically inspect the interior surfaces of the NMP-1 emergency diesel fuel oil tanks and diesel fire pump fuel oil day tank, and the NMP-2 fuel oil tanks for evidence of significant degradation, including a specific requirement that the tank bottom thickness be determined; (5) add a requirement for quarterly trending of particulate contamination analysis results; and (6) ensure acceptance criteria are specified in the implementing procedures for the applicable indications of potential degradation.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.28.3.2 Effectiveness and Implementation of AMP XI.M30

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 2, “Scope of Program,” states that “coatings, if used, prevent or mitigate corrosion by protecting the internal surfaces of the tank from contact with water and microbiological organisms.” However, no further guidance is provided on types of coatings that are effective in controlling corrosion and are compatible with the fuel oil. In addition, no guidance is given on inspection techniques to verify the integrity of these coatings. An appropriate industry standard or other guidance is desirable here.

(b) Program Element 4, “Detection of Aging Effects,” states that “Prior to the period of extended operation, a one-time inspection (i.e., AMP XI.M32) of selected components exposed to diesel fuel oil is performed to verify the effectiveness of the Fuel Oil Chemistry program.” The wording here should be clarified to indicate that this one-time inspection must be repeated prior to entering each PEO (i.e., another one-time inspection is required prior to license extension beyond 60 years).

4.2.28.4 Recommendations for Subsequent License Renewal

4.2.28.4.1 Good Practices or Strengths of AMP XI.M30

No specific good practice was identified during the review.

4.2.28.4.2 Areas of AMP XI.M30 for Further Consideration/Enhancement

Program Description:

M28.0-1: *Recommendation*: Consider providing additional guidance on tank bottom thickness measurements and acceptance criteria.
***Technical Basis*:** The program description states that thickness measurement of tank bottom surfaces is an acceptable method to verify program effectiveness, but it provides no further guidance on acceptable methods for determining the thickness of the fuel oil tank bottom or on acceptance criteria. Two UT inspections of the fuel oil tanks performed at NMP found regions where the local thickness was less than the acceptance criteria, and engineering evaluations were performed to verify the structural integrity of the tank. An industry standard or some other guidance is desirable to address tank bottom thickness determinations and acceptance criteria in more detail.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

M28.2-1: *Recommendation*: Consider providing additional guidance on the use of coatings for the corrosion protection of fuel oil tanks.
***Technical Basis*:** Program Element 2 states that "coatings, if used, prevent or mitigate corrosion by protecting the internal surfaces of the tank from contact with water and microbiological organisms." However, no further guidance is provided on types of coatings that are effective in controlling corrosion and are compatible with the fuel oil. In addition, no guidance is given on inspection techniques to verify the integrity of these coatings. An appropriate industry standard or other guidance is desirable here.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M28.4-1: *Recommendation*: Clarify the wording of Program Element 4 to indicate that the one-time inspection called for in Program Element 4 must be repeated prior to entering each PEO (i.e., another one-time inspection is required prior to license extension beyond 60 years).
***Technical Basis*:** Program Element 4 states that "Prior to the period of extended operation, a one-time inspection (i.e., AMP XI.M32) of selected components exposed to diesel fuel oil is performed to verify the effectiveness of the Fuel Oil Chemistry program." However, it does not specifically address subsequent PEOs.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.29 Reactor Vessel Surveillance (XI.M31)

4.2.29.1 Objective and Scope of Rev. 2 AMP XI.M31

The *Code of Federal Regulations*, 10 CFR Part 50, Appendix H, requires that peak neutron fluence at the end of the design life of the vessel will not exceed 10^{17} n/cm^2 (E > 1 MeV), or that reactor vessel beltline materials be monitored by a surveillance program to meet the ASTM E 185 Standard. However, the surveillance program in ASTM International Standard Practice E 185-82 is based on plant operation during the current license term, and additional surveillance capsules may be needed for the PEO. Alternatively, an integrated surveillance program for the PEO may be considered for a set of reactors that have similar design and operating features in accordance with 10 CFR Part 50, Appendix H (2009), Paragraph III.C. Additional surveillance capsules may also be needed for the PEO for this alternative.

The objective of the reactor vessel material surveillance program is to provide sufficient material data and dosimetry to: (a) monitor irradiation embrittlement at the end of the PEO: and, (b) determine the need for operating restrictions on the inlet temperature, neutron spectrum, and neutron flux. If surveillance capsules are not withdrawn during the PEO, operating restrictions are to be established to ensure that the plant is operated under the conditions to which the surveillance capsules were exposed.

The program is a condition monitoring program that measures the increase in Charpy V-notch 30 foot-pound (ft-lb) transition temperature and the drop in the upper shelf energy as a function of neutron fluence and irradiation temperature. The data from this surveillance program are used to monitor neutron irradiation embrittlement and are used in the time-limited aging analyses that are described in Section 4.2 of the SRP-LR. All capsules in the reactor vessel that are removed and tested must meet the test procedures and reporting requirements of the 1982 edition of ASTM E 185 (ASTM E 185-82), to the extent practicable, for the configuration of the specimens in the capsule. Any changes to the capsule withdrawal schedule, including spare capsules, must be approved by the NRC prior to implementation. Untested capsules placed in storage must be maintained for possible future insertion.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) 10 CFR Part 50, Appendix H, *Reactor Vessel Material Surveillance Program Requirements*, 2009; and
(ii) ASTM E 185-82, *Standard Practice for Conducting Surveillance Tests of Light-Water Cooled Nuclear Power Reactor Vessels*, 1982.

4.2.29.2 Observations from Ginna and NMP-1

This program is implemented at Ginna through AMP B2.1.28, “Reactor Vessel Surveillance.” The Ginna AMP lists no exceptions or enhancements to the GALL Report, Rev. 0.

Section 4.0 of the Ginna PBD, Rev. 4, states that the licensee’s reactor vessel surveillance program includes the following subprograms: (a) surveillance capsule insertion, withdrawal and evaluation; (b) fluence and uncertainty calculations; (c) monitoring of effective full-power years (EFPY); (d) development of pressure-temperature limit curves; and (e) calculation and monitoring of low-temperature overpressure protection (LTOP). In the Ginna LRA, the licensee indicated that, when capsules are removed, the neutron dosimetry data from the withdrawn capsules are evaluated to validate the fluence calculation. In addition, the PBD indicates that monitoring of EFPY is necessary to enable a projection of the fluence of the reactor vessel beltline material as a function of time. The PBD further indicates that pressure-temperature

(P-T) limit curves are normally developed based on a particular projection of EFPY, beyond which they are not valid. The PBD also indicates that EFPY calculations are performed at Ginna by using the daily reactor power log.

Ginna indicated that the last capsule (sixth capsule, P) is expected to be withdrawn approximately in 2018 after its exposure to the fluence level equivalent to that projected for the reactor vessel after 80 years operation.

NMP-1 implements this program through its AMP B2.1.19, "Reactor Vessel Surveillance Program." Further details are available in the AEA TLR, ML13122A009.

In addition, the staff also required the following license condition:

> "Implementation of the most recent staff-approved version of the BWRVIP ISP as the method to demonstrate compliance with the requirements of 10 CFR Part 50, Appendix H. Any changes to the BWRVIP ISP capsule withdrawal schedule must be submitted for NRC staff review and approval. Any changes to the BWRVIP ISP capsule withdrawal schedule, which affects the time of withdrawal of any surveillance capsule, must be incorporated into the licensing basis. If any surveillance capsules are removed without the intent to test them, these capsules must be stored in manner which maintains them in a condition which would support re-insertion into the reactor pressure vessel, if necessary."

As part of its Reactor Vessel Surveillance Program, NMP-1 is participating in an ISP as described in BWRVIP-116. However, it was noted during the audit that the ISP provisions of BWRVIP-116 and BWRVIP-86-A were recently merged into BWRVIP-86, Rev. 1, which was approved by the NRC in October 2011 and superseded BWRVIP-116. During the audit interview, NMP-1 personnel indicated that their ISP is being updated to conform to the new guidance in BWRVIP-86, Rev. 1.

4.2.29.3 Effectiveness of AMP XI.M31 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.29, "AMP Worksheet XI.M31 Reactor Vessel Surveillance." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal (LR, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.29.4.

4.2.29.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant conclusions from an assessment of the adequacy of the program description are as follows:

(a) The Ginna SER Appendix A includes Commitment 38 under which the licensee agreed to the following: (1) withdraw a surveillance capsule in Spring 2005 and submit a test report of the results within 1 year; and (2) withdraw the last surveillance capsule shortly after accumulating fluence equivalent to 80 years of operation. However, in a letter dated May 29, 2009 (supplemented Feb. 18, 2010), the licensee submitted WCAP-17036-NP, Rev. 0, “Analysis of Capsule N from the R. E. Ginna Reactor Vessel Radiation Surveillance Program," to the NRC. Note (3) of Table 7-1, in WCAP-17036-NP states that Capsule P should be removed at about 33.9 EFPY to fulfill the commitment of [28] to remove the capsule shortly after it accumulates a fluence equivalent to 80 years of operation (reference [28] refers to the NRC SER for Ginna LR).

However, WCAP-17036-NP does not clearly address how the licensee has been keeping track of the implantation schedule for the LR commitments, especially the first item of LR Commitment 38. In fact, WCAP-17036-NP does not provide a specific reference to LR Commitment 38, even though the major topic of the WCAP report is the test and analysis results for Capsule N, which is, in turn, directly relates to LR Commitment 38. However, the foregoing information indicate a need for the GALL Report to provide more specific guidance for how the applicants/licensees should communicate with the NRC when the LR commitments are modified or their implementing schedules are changed.

The AMPs implemented by both Ginna and NMP-1, and by most of the LR applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M20, with some exceptions and enhancements. The Ginna Reactor Vessel Surveillance Program claims consistency with GALL, Rev. 0, with no exceptions, enhancements, or commitments. However, during its LR audit, the NRC identified an apparent exception to GALL guidance related to the schedule for withdrawing surveillance capsules for testing. After additional clarification, the staff found this exception acceptable.

The NMP Reactor Vessel Surveillance Program takes no exceptions to GALL, Rev. 0, but adds the following enhancements: (1) incorporate the requirements and elements of the ISP, as documented in BWRVIP-116 and approved by NRC, or an NRC approved plant-specific program, into the Reactor Vessel Surveillance Program, and include a requirement that if NMP Nuclear Station surveillance capsules are tested, the tested specimens will be stored in lieu of optional disposal; and (2) project analyses of upper shelf energy and pressure-temperature limits to 60 years using methods prescribed by RG 1.99, Rev. 2, and include the applicable bounds of the data, such as operating temperature and neutron fluence. In addition, the NRC staff also required the following license condition: “Implementation of the most recent staff-approved version of the BWRVIP ISP as the method to demonstrate compliance with the requirements of 10 CFR Part 50, Appendix H. Any changes to the BWRVIP ISP capsule withdrawal schedule must be submitted for NRC staff review and approval. Any changes to the BWRVIP ISP capsule withdrawal schedule which affects the time of withdrawal of any surveillance capsules must be incorporated into the licensing basis. If any surveillance capsules are removed without the intent to test them, these capsules must be stored in manner which maintains them in a condition which would support re-insertion into the reactor pressure vessel, if necessary.”

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR. This is considered to be important and may be evaluated in future efforts.

4.2.29.3.2 Effectiveness and Implementation of AMP XI.M31

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 3, "Parameters Monitored/Inspected," recommends the use of neutron dosimeters to benchmark the neutron fluence calculations. RG 1.191, issued in March 2001, provides state-of-the-art calculations and measurement procedures that are acceptable to the NRC staff for determining pressure vessel fluence. However, GALL, Rev. 2, does not refer to RG 1.191.

4.2.29.4 Recommendations for Subsequent License Renewal

4.2.29.4.1 Good Practices or Strengths of AMP XI.M31

No specific good practice was identified during the review.

4.2.29.4.2 Areas of AMP XI.M31 for Further Consideration/Enhancement

Program Description:

M29.0-1: ***Recommendation*:** Provide more specific guidance in the SRP and GALL on communicating changes in LR commitments or implementation schedules.
***Technical Basis*:** The Ginna SER, Appendix A, includes Commitment 38 under which the licensee agreed to: (1) withdraw surveillance capsule in Spring 2005 and submit test report of results within 1 year;; and, (2) withdraw the last surveillance capsule shortly after accumulating fluence equivalent to 80 years of operation. However, in a letter dated May 29, 2009 (supplemented Feb. 18, 2010), the licensee submitted WCAP-17036-NP, Rev. 0, "Analysis of Capsule N from the R. E. Ginna Reactor Vessel Radiation Surveillance Program," to the NRC. Note (3) of Table 7-1, in WCAP-17036-NP states that Capsule P should be removed at about 33.9 EFPY to fulfill the commitment of [28] to remove the capsule shortly after it accumulates a fluence equivalent to 80 years of operation (reference [28] refers to the NRC SER for Ginna LR). However, WCAP-17036-NP does not clearly address how the licensee has been keeping track of the implantation schedule for the LR commitments, especially the first item of LR Commitment 38. In fact, WCAP-17036-NP does not provide a specific reference to LR Commitment 38, even though the major topic of the WCAP report is the test and analysis results for Capsule N, which is, in turn, directly relates to LR Commitment 38. This indicates a need for the GALL Report and SRP-LR to provide more specific guidance for how the applicants/licensees should communicate with the NRC when the LR commitments are modified or their implementing schedules are revised.

M29.0-2: ***Recommendation*:** Verify that the guidance cited in the on the Reactor Vessel Surveillance AMP for LTO is current and complete.
***Technical Basis*:** The program basis and supporting documents cited in GALL are subject to revisions and updates, and the guidance cited by the applicant may not reflect these revisions and updates. Unless the program basis and supporting documents are current and complete, the applicant's AMP for LTO will not represent the best available guidance for aging management.

1. Scope of Program:

M29.1-1: ***Recommendation*:** Verify that the applicant's PBD)is continually updated in a timely manner.
***Technical Basis*:** Section 4.0 of the Ginna PBD, Rev. 4, states that the licensee's reactor vessel surveillance program includes the following subprograms: (1) surveillance capsule insertion, withdrawal and evaluation; (2) fluence and uncertainty calculations; (3) monitoring of effective full-power years; (4) development of pressure-temperature limit curves; and (5) calculation and monitoring of LTOP. However, no updates have been made to the PBD since April 2009.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

M29.3-1: ***Recommendation*:** For LTO, the GALL Report should include RG 1.190 as a reference and provide guidance for fluence calculation, benchmark, and validation.

***Technical Basis*:** This program element recommends the use of neutron dosimeters to benchmark the neutron fluence calculations. RG 1.190, issued in March 2001, provides state-of-the-art calculations and measurement procedures that are acceptable to the NRC staff for determining pressure vessel fluence. However, the GALL Report, Rev. 2, does not refer to RG 1.190 but states that preferentially irradiation temperature will be monitored from cold leg operating temperatures. By contrast, the Ginna surveillance program states that the accumulated neutron fluence is monitored from the irradiated material specimens. The program does not clearly address how the licensee's program benchmarks the neutron fluence calculations using the neutron dosimeters. In addition, the program does not clearly describe how it uses the data of the ongoing neutron dosimeter measurements to validate the previous calculations for fluence projections. Furthermore, the program does not clearly describe how the cold leg temperatures, which may affect the degree of reactor vessel irradiation embrittlement, are collected and analyzed in the reactor vessel surveillance program.

M29.3-2: *Recommendation*: For LTO, the GALL Report should include the more detailed guidance for the validation of fluence calculations and projections.
***Technical Basis*:** In the Ginna LRA, the licensee indicated that when a capsule is removed, the neutron dosimetry data from the withdrawn capsules are evaluated to validate the fluence calculation. In addition, the PBD indicates that monitoring of EFPY is necessary to enable a projection of the fluence of the reactor vessel belt-line material as a function of time. The PBD indicates that PT curves are normally developed based on a particular projection of EFPY, beyond which they are not valid. The PBD also indicates that EFPY calculations are performed at Ginna Station by using the Daily Reactor Power Log. During the audit, the licensee indicated that it has no formal procedure for the projection of the fluence; however, the engineering staff performs the projections using the power data. Furthermore, the licensee (or the PBD) did not clearly address how frequently the ongoing dosimetry data are used to validate the flux/fluence calculations and projections, especially between the refueling outages when capsules are withdrawn.

M29.3-3: *Recommendation*: The guidance for determining the "limiting material" in this AMP may require updating for LTO.
***Technical Basis*:** As the fluence level is increased, non-belt-line material such as reactor vessel nozzles may become a limiting material. The license renewal guidance, especially for the subsequent license renewal period, should more clearly address the definition of "limiting material." As the reactor vessel materials continue to be exposed to neutron irradiation fluence and age, the list of the "limiting" materials should be updated accordingly and relevant testing and analysis should be performed to ensure that "newly-identified" limiting materials/locations are adequately evaluated.

M29.3-4: *Recommendation*: Reevaluate GALL options with respect to integrated surveillance programs and provide detailed guidance on an alternative neutron monitoring program.
***Technical Basis*:** Ginna indicated that the last capsule (sixth capsule P) is expected to be withdrawn in about 2018 after exposure to the 80-year-operation fluence level projected for the reactor vessel. It is noted that if Ginna were to continue its operation for the subsequent license renewal period, it would enter the second license renewal period in 2029, which means that if no additional capsule is reinstituted, Ginna would operate for additional 30 years without a capsule in the reactor vessel. In the broader picture, extended operation beyond 60 years increases the likelihood that a number of licensees will exhaust their supply of surveillance capsules in the reactor vessel. This means that they will increasingly be forced to rely on the alternatives given in GALL AMP XI.M31. Currently, the GALL Report recommends that if all surveillance capsules have been removed, a licensee may seek membership in an integrated surveillance program

unless the integrated surveillance program does not have surveillance material representative of its limiting belt-line materials or the program can propose one of the following: (a) an active surveillance program with reinstituted specimens; or, (b) an alternative neutron monitoring program. However, further evaluation may be needed to confirm that one of the foregoing two options is sufficient to adequately manage aging. Both options may possibly be necessary in some cases. In addition, the GALL Report does not provide detailed guidance for an Alternative Neutron Monitoring Program.

4. Detection of Aging Effects:

M29.4-1: ***Recommendation*****:** Ensure that latest NRC-approved industry guidance is incorporated into AMP with respect to ISPs.
Technical Basis**:** As a part of its reactor vessel surveillance AMP, NMP-1 is participating in an ISP as described in BWRVIP-116. However, the ISP provisions of BWRVIP-116 and BWRVIP-86-A have recently been merged into BWRVIP-86, Rev. 1, which was approved by the NRC in October 2011 and supersedes BWRVIP-116. During the audit interview, NMP-1 personnel indicated that their ISP is being updated to conform to the new guidance in BWRVIP-86, Rev. 1. This same guidance should be incorporated into updated GALL guidance on an ISP for LTO.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.30 One-Time Inspection (XI.M32)

4.2.30.1 Objective and Scope of Rev. 2 AMP XI.M32

A one-time inspection of selected components is used to verify the system-wide effectiveness of an AMP that is designed to prevent or minimize aging to the extent that it will not cause the loss of intended function during the PEO. For example, effective control of water chemistry under the XI.M2, "Water Chemistry," program can prevent some aging effects and minimize others. However, there may be locations that are isolated from the flow stream for extended periods and are susceptible to the gradual accumulation or concentration of agents that promote certain aging effects. This program provides inspections that verify that unacceptable degradation is not occurring. It also may trigger additional actions that ensure the intended functions of affected components are maintained during the PEO.

The program verifies the effectiveness of an AMP and confirms the insignificance of an aging effect. Situations in which additional confirmation is appropriate include (a) an aging effect is not expected to occur, but the data are insufficient to rule it out with reasonable confidence; or (b) an aging effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected. For these cases, confirmation demonstrates that either the aging effect is not occurring or that the aging effect is occurring very slowly and does not affect the component's or structure's intended function during the PEO based on prior OpE data.

This program does not address Class 1 piping less than NPS 4. That piping is addressed in AMP XI.M35, "One Time Inspection of ASME Code Class 1 Small Bore-Piping."

The elements of the program include (a) determination of the sample size of components to be inspected based on an assessment of materials of fabrication, environment, plausible aging effects, and OpE; (b) identification of the inspection locations in the system or component based on the potential for the aging effect to occur; (c) determination of the examination technique, including acceptance criteria that would be effective in managing the aging effect for which the component is examined; and (d) evaluation of the need for follow-up examinations to monitor the progression of aging if age-related degradation is found that could jeopardize an intended function before the end of the PEO.

An acceptable (one-time inspection) program to verify system-wide effectiveness of an AMP may consist of a one-time inspection of selected components and susceptible locations in the selected system. Verification may include a review of routine maintenance, repair, or inspection records to confirm that selected components have been inspected for aging degradation and that significant aging degradation has not occurred. A one-time inspection program is acceptable to verify the effectiveness of AMP XI.M2, "Water Chemistry"; AMP XI.M30, "Fuel Oil Chemistry"; and AMP XI.M39, "Lubricating Oil Analysis," programs or where the environment in the PEO is expected to be equivalent to that in the prior 40 years and for which no aging effects have been observed. However, one-time inspection for environments that do not fall in this category, or of any other action or program created to verify the effectiveness of an AMP and confirm the absence of an aging effect, is to be reviewed by the Staff on a plant-specific basis.

This program cannot be used for structures or components with known age-related degradation mechanisms or when the environment in the PEO is not expected to be equivalent to that in the prior 40 years. Periodic inspections should be proposed in these cases.

This AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a;
(ii) BWRVIP-03 (EPRI 105696-R6), *BWR Vessel and Internals Project: Reactor Pressure Vessel and Internals Examination Guidelines*, January 6, 2004, June 2008; and
(iii) MRP-228, *Materials Reliability Program: Inspection Standard for PWR Internals*, 2009.

4.2.30.2 Observations from Ginna and NMP-1

This program was implemented at Ginna through its AMP B2.1.21, "One-Time Inspection". NMP-1 implements this program through its AMP B2.1.20, "One-Time Inspection Program." Both the Ginna and NMP-1 AMPs were new programs to be implemented prior to entering the PEO. Further details are available in the AEA TLR, ML13122A009.

During the Ginna audit, an issue was raised about SCC of SS in an environment less than 140°F. The site identified multiple examples for thin-walled piping (Schedule 10) that showed sensitization of the weld HAZ. During discussions, licensee personnel said a new OpE document was not considered, since this problem did not meet the site's criteria for issuing OpE. The auditor noted that the staff should consider a need to add a new AMR line item in the GALL Report to address SCC of thin-walled SS piping at temperatures below 140°F.

It was noted during the audits that the One-Time Inspection Program provides a means to verify the performance of other AMPs (e.g., water chemistry control), where the environment in the PEO is expected to be equivalent to that in the prior 40 years, and for which no aging effects have been observed. The program description states that this AMP is applicable to situations where: (a) an aging effect is not expected to occur, but the data are insufficient to rule it out with reasonable confidence; or (b) an aging effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected. As documented in IR 05000244/2009007 and IR 05000244/2009009 for Ginna, three out of the 30 material/environment groups merited periodic inspections as a result of finding corrosion during the one-time inspections. These included cast iron in drainage raw water, carbon steel in raw water, and carbons steel in treated water. Ginna planned to perform these inspections through the Periodic Surveillance and Preventive Maintenance program. As documented in IR 05000220/2009007 for NMP-1, of the 13 material/environment groups established for the one-time inspections, only components in the carbon steel in treated water group merited periodic inspections, and these inspections were to be performed through the preventive maintenance program.

4.2.30.3 Effectiveness of AMP XI.M32 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.30, "AMP Worksheet XI.M32 One-Time Inspection." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The

recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.30.4.

Thus, this AMP relies on the requirements or guidance from the following documents:
(i) ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a;
(ii) BWRVIP-03 (EPRI 105696- R6), *BWR Vessel and Internals Project: Reactor Pressure Vessel and Internals Examination Guidelines*, January 6, 2004, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, June 2008; and
(iii) MRP-228, *Materials Reliability Program: Inspection Standard for PWR Internals*, 2009.

4.2.30.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M32. Both the Ginna One-Time Inspection Program and the NMP One-Time Inspection Program claim consistency with GALL, Rev. 0, with no exceptions or enhancements.

Information on possible effects of plant modifications in this AMP was not evaluated in this TLR.

4.2.30.3.2 Effectiveness and Implementation of AMP XI.M32

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

4.2.30.4 Recommendations for Subsequent License Renewal

4.2.30.4.1 Good Practices or Strengths of AMP XI.M32

No specific good practice was identified during the review.

4.2.30.4.2 Areas of AMP XI.M32 for Further Consideration/Enhancement

Program Description:

M30.0-1: ***Recommendation*:** The details of this AMP should be reviewed on a plant-specific basis when applied to LTO.
***Technical Basis*:** The One-Time Inspection Program provides an acceptable means to verify the effectiveness of other AMPs where the environment in the PEO is expected to be equivalent to that in the prior 40 years and for which no aging effects have been observed. The program description states that this AMP is applicable to situations where (a) an aging effect is not expected to occur, but the data are insufficient to rule it out with reasonable confidence; or (b) an aging effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected. The same criteria for the applicability of the One-Time Inspection Program may be applied to operation beyond 60 years. However, in view of the increased service times of the components subject to inspection, the details of the program with respect to sample size and sampling and inspection techniques

should be reviewed on a plant-specific basis to ensure that the program is sufficiently rigorous to detect degradation that was not detectable after 40 years but has become significant after an additional 20 years.

1. <u>Scope of Program</u>:

M30.1-1: *Recommendation*: Revise the appropriate GALL table(s) to include an AMR line item on sensitization and possible SCC of SS piping at temperatures <140°F, per NRC IN 2011-04.
***Technical Basis*:** During the Ginna audit, an issue was raised about SCC of SS in an environment less than 140°F. The site identified multiple examples for thin-walled piping (schedule 10) that showed sensitization of the weld HAZ. During discussions, licensee personnel said a new OpE document was not considered, since this issue is specifically addressed in NRC IN 2011-04, "Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Steel Piping in Pressurized Water Reactors." Although this does not specifically impact the One-Time Inspection Program, consideration should be made to include an AMR line item to address this issue.

M30.1-2: *Recommendation*: Consider revising the relevant program elements to include additional AMPs subject to confirmation by one-time inspection. Expand the table under Program Element 4 as necessary to include additional parameters monitored and inspection techniques.
***Technical Basis*:** GALL, Rev. 2, states under XI.M32 Program Element 1 that "the scope of this program includes systems and components that are subject to aging management using the GALL AMPs XI.M2, "Water Chemistry"; XI.M30, "Fuel Oil Chemistry"; and XI.M39, "Lubricating Oil Analysis," and for which no aging effects have been observed or for which the aging effect is occurring very slowly and does not affect the component's or structure's intended function during the PEO based on prior OpE data." However, for extended operation beyond 60 years, one-time inspections may be required to verify the system-wide effectiveness of other AMPs in addition to XI.M2, XI.M30, and XI.M39. Aging processes determined to be too slow to produce failure during extended plant operation to 60 years may become problematic beyond 60 years, and a one-time inspection can be used to verify the absence of significant degradation for a wide variety of SSCs.

The purpose of these inspections would be similar to that stated in the present AMP XI.M32, namely to verify the effectiveness of an AMP and confirm the insignificance of an aging effect. The additional AMPs to which one-time inspections might be applied include XI.M3 ("Reactor Head Closure Stud Bolting"), XI.M10 ("Boric Acid Corrosion"), XI.M17 ("Flow-Accelerated Corrosion"), XI.M18 ("Bolting Integrity"), XI.M27 ("Fire Water System"), XI.M33 ("Selective Leaching"), and XI.M41 ("Buried and Underground Piping and Tanks"), among others.

<u>2. Preventive Action:</u>

No further review item identified.

<u>3. Parameters Monitored/Inspected:</u>

No further review item identified. .

<u>4. Detection of Aging Effects:</u>

See recommendation 30.1-2 above.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.31 Selective Leaching (XI.M33)

4.2.31.1 Objective and Scope of Rev. 2 AMP XI.M33

This program demonstrates the absence of selective leaching in components made of gray cast iron and copper alloys. The AMP for selective leaching of materials ensures the integrity of the components made of gray cast iron and copper alloys (except for inhibited brass) that contain greater than 15 percent zinc or greater than 8 percent aluminum in the case of aluminum-bronze exposed to a raw water, closed cooling water, treated water, or groundwater environment that may lead to selective leaching of one of the metal components where there has not been previous experience of selective leaching. The AMP includes a one-time visual inspection of selected components that may be susceptible to selective leaching, coupled with either hardness measurements (where feasible, based on form and configuration) or other mechanical examination techniques. These techniques can determine whether loss of materials due to selective leaching is occurring and whether selective leaching will affect the ability of the components to perform their intended function during the PEO.

The selective leaching process involves the preferential removal of one of the alloying elements from the material, which leads to the enrichment of the remaining alloying elements. Dezincification (loss of zinc from brass) and graphitization (removal of iron from cast iron) are examples of such a process. Susceptible materials, high temperatures, stagnant-flow conditions, and a corrosive environment, such as acidic solutions for brasses with high zinc content and dissolved oxygen, are conducive to selective leaching.

Although the program does not provide guidance on preventive action, it is noted that monitoring of water chemistry to control pH and concentration of corrosive contaminants and treatment to minimize dissolved oxygen in water are effective in reducing selective leaching. Water chemistry is managed by the Water Chemistry program (AMP XI.M2).

This AMP relies on the requirements or guidance from the following document:
(i) EPRI TR-107514, *Age Related Degradation Inspection Method and Demonstration*, 1998.

4.2.31.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.29, “Selective Leaching.” Further details are available in the AEA TLR, ML13122A009.

Visual inspections at Ginna identified one case of confirmed selective leaching in the gray cast iron drain plug of an auxiliary FW pump outboard bearing cooler. Evidence of degradation was also found on five other pumps but could not be definitely determined to be a result of selective leaching. Possible selective leaching was also found on multimatic valves on the underside of the clapper. As a result of these observations and in conformance with GALL Report AMP XI.M33, a plant-specific program has been developed whereby the components in question are inspected every quarter under the Ginna Preventive Surveillance and Periodic Maintenance program. If follow-on destructive examinations verify selective leaching in one of the suspect pumps, all six pumps will be replaced with cast steel pumps.

The NMP-1 AMP B2.1.21, “Selective Leaching Program,” was identified as a new program in the LRA and was implemented through the One-Time Inspection Program. Further details are available in ML13122A009.

The NMP-1 PBD, Rev. 0, provides considerable detail as to the SSCs, materials, and environments to which the program applies, but it was not clear about inspection techniques. It states, “field hardness testing due to the capabilities of portable equipment and efforts necessary to qualify material-specific test procedures is not planned on site.” However, under “Detection of Aging Effects” of the same table, the assessment of consistency states, “where practical, field hardness testing will be performed in lieu of off-site testing.” In the audit interview, the licensee clarified that field hardness testing is performed where practical; due to the size and geometry of the portable tester, there are limited locations where it is able to be used. . NMP-1 inspected 25 copper alloy and 29 gray cast iron components. The samples were selected randomly following EPRI guidance on an appropriate sample size. No selective leaching was detected in this inspection, though condition reports were written for other conditions such as MIC and fouling. One destructive evaluation was conducted later on a copper alloy component, which determined that no leaching was present. However, the component was found to contain less than 15 percent zinc, and was therefore not susceptible. Based on this destructive evaluation, 12 other copper alloy samples, selected in the sampling plan as described above, were determined to be insusceptible to leaching.

4.2.31.3 Effectiveness of AMP XI.M33 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.31, “AMP Worksheet XI.M33 Selective Leaching.” The significant conclusions related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.31.4.

4.2.31.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The AMPs implemented by both Ginna and NMP-1 plants, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M33, with exceptions and enhancements. The Ginna Selective Leaching of Materials Program claims consistency with GALL, Rev. 0, with the exception that hardness testing will not be performed as part of the program. Instead, the feasibility of performing hardness tests and the value of hardness test data will be assessed on a component-specific basis. The NMP Selective Leaching Program claims consistency with GALL, Rev. 0, with no exceptions or enhancements. The Ginna AMP contains no commitments. It is noted that the Ginna Selective Leaching of Materials Program utilizes visual inspections performed under its Periodic Surveillance/Preventive Maintenance Program or its One-Time Inspection Program to determine whether selective leaching is occurring in susceptible components. Likewise, the NMP Selective Leaching Program is implemented through its One-Time Inspection Program. The

NMP LRA includes a commitment to develop and implement the One-Time Inspection Program prior to the PEO that also includes the attributes for a selective Leaching of Materials Program.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR. This aspect could be important and may be analyzed in future efforts.

4.2.31.3.2 Effectiveness and Implementation of AMP XI.M33

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant conclusions from the evaluation are as follows:

(a) Program Element 4, "Detection of Aging Effects," calls for a one-time inspection for selective leaching to be performed within the last 5 years prior to entering the PEO. This text should be clarified to state that this same one-time inspection should be performed prior to entering into each PEO (i.e., LTO).

4.2.31.4 Recommendations for Subsequent License Renewal

4.2.31.4.1 Good Practices or Strengths of AMP XI.M33

M31.S-1: *Recommendation*: During inspections, Ginna found one example of selective leeching (graphitization) in an auxiliary feedwater pump outboard bearing cooler drain plug. Evidence of aging was also found on five other pumps, but whether it could not be definitely determined that the aging was due to selective leaching. In addition, some evidence of selective leaching was found on multimatic valves on the underside of the clapper. As a result of all these findings, inspection frequency in this program has been increased; in response to these findings, corrective actions have been moved into the Preventive Surveillance and Periodic Maintenance Program so that the affected components are inspected every quarter. This response is considered a good practice and should be included as a part of Program Element 5, "Monitoring and Trending."
***Technical Basis*:** An increase in inspection frequency is an appropriate response to the detection of possible aging effects.

4.2.31.4.2 Areas of AMP XI.M33 for Further Consideration/Enhancement

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M31.4-1: *Recommendation*: The text of this program element should be clarified to state that a one-time inspection should be performed prior to entering into *each* PEO (i.e., LTO).
***Technical Basis*:** As noted above, Program Element 4 calls for a one-time inspection for selective leaching to be performed within the last 5 years prior to entering the PEO. However, it does not state that this same one-time inspection is required for subsequent extended operating periods.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M31.10-1: *Recommendation*: Revise AMP XI.M33 as necessary for LTO in response to future OpE.
***Technical Basis*:** Aside from some notable exceptions, OpE with respect to selective leaching in nuclear plants has been generally favorable. However, it is essential to continue to closely monitor future industry and plant-specific OpE, particularly during the initial 20-year license extension period. In the unlikely event of a dramatic increase in selective leaching degradation problems, a reevaluation and possible revision of the present AMP XI.M33 may be required before it is applied to LTO.

4.2.32 One-Time Inspection of ASME Code Class 1 Small-Bore Piping (XI.M35)

4.2.32.1 Objective and Scope of Rev. 2 AMP XI.M35

This program augments the requirements in ASME Code, Section XI, 2004 edition. According to Table IWB-2500-1, Examination Category B-J, Item No. B9.21 and B9.40 of the current ASME Code, an external surface examination of small-bore Class 1 piping should be included for piping less than NPS 4. Other ASME Code provisions exempt from examination piping NPS 1 and smaller. This program is augmented to include piping from NPS 1 to less than NPS 4. In addition, Examination Category B-P requires system leakage tests of all Class 1 piping. However, the Staff believes that for a one-time inspection to detect cracking resulting from thermal and mechanical loading or intergranular stress corrosion of full-penetration welds, the inspection should be a volumetric examination. For a one-time inspection to detect cracking in socket welds, the inspection should be either a volumetric or opportunistic destructive examination. (Opportunistic destructive examination is performed when a weld is removed from service for other considerations, such as plant modifications. A sampling basis is used if more than one weld is removed.) These examinations provide additional assurance that either aging of small-bore ASME Code Class 1 piping is not occurring or the aging is insignificant, such that a plant-specific AMP is not warranted, and is applicable to small-bore ASME Code Class 1 piping and systems less than 4 inches nominal pipe size (less than NPS 4) and greater than or equal to NPS 1. The program includes pipes, fittings, branch connections, and all full and partial penetration (socket) welds.

This program is applicable to systems that have not experienced cracking of ASME Code Class 1 small-bore piping. This program can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking. (Measures of effectiveness includes [1] the one-time inspection sampling is statistically significant; [2] samples will be selected as described in Element 5, Monitoring and Trending below; and [3] no repeated failures over an extended period of time.) For systems that have experienced cracking and OpE indicates that design changes have not been implemented to effectively mitigate cracking, periodic inspection is proposed, as managed by a plant-specific AMP. If evidence of cracking be revealed by a one-time inspection, periodic inspection is implemented using a plant-specific AMP.

If small-bore piping in a particular plant system has experienced cracking, small-bore piping in all plant systems are evaluated to determine whether the cause for the cracking affects other systems (corrective action program).

Thus, this AMP relies on the requirements or guidance from the following document:
(i) ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a.

4.2.32.2 Observations from Ginna and NMP-1

The Ginna and NMP-1 LRAs were prepared under GALL Report, Rev. 0, guidance and do not include a separate AMP for the inspection of ASME Code Class 1 small-bore piping. The Ginna LRA manages the aging of small-bore piping through its AMPs “One-Time Inspection” and “Water Chemistry Control.” Similarly, the NMP LRA manages this aging effect through its “One-Time Inspection Program,” “Water Chemistry Control Program,” and “ASME Section XI

Inservice Inspection (Subsections IWB, IWC, IWD) Program." Therefore, this AMP was not reviewed during the audits.

4.2.32.3 Effectiveness of AMP XI.M35 to Meet Its Objective

The preliminary AEA reports from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. There was no separate audit report for XI.M35; the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, in which the inspection of small-bore piping was included under the One-Time Inspection Program XI.M32. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.32, "AMP Worksheet XI.M35 One-Time Inspection of ASME Section I Small-Bore Piping." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.32.4.

4.2.32.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) LRAs prepared under GALL, Rev. 0, guidance do not include a separate AMP for the inspection of Class 1 small-bore piping. Instead, the inspection of small-bore piping was included under the GALL, Rev. 0, One-Time Inspection Program XI.M32. However, overall OpE has shown that the cracking of small-bore piping is a widespread problem, and a separate AMP to manage this form of degradation was added to Revisions 1 and 2 of the GALL Report. Therefore, it is necessary to ensure that a satisfactory AMP for the inspection of Class 1 small-bore piping that is consistent with GALL, Rev. 2 AMP XI.M35 is in place prior to entering LTO.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.32.3.2 Effectiveness and Implementation of AMP XI.M35

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) GALL, Rev. 2, Program Element 4, "Detection of Aging Effects," states in the second sentence that "this inspection does <u>not</u> apply to those plants that have experienced cracking due to stress corrosion, cyclical (including thermal, mechanical, and vibration fatigue) loading, or thermal stratification and thermal turbulence MRP 146 and MRP 146S)." However, in the second paragraph of the same program element, the AMP states that "If the

applicant has successfully mitigated any failures in its ASME Class 1 piping, the inspection should include 10% of the weld population or a maximum of 25 welds of each weld type…" In addition, in the second sentence of the second paragraph of the Program Description section, the AMP states, "This program can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking." This apparent contradiction concerning the applicability of AMP XI.M35 to plants that have experienced cracking needs to be clarified. It appears that the second sentence of Program Element 4 is either incorrect or is worded in such a way as to create confusion.

(b) Program Element 4, "Detection of Aging Effects," states in the last sentence of the second paragraph that "The one time inspection should be completed within the six year period prior to the period of extended operation." However, it makes no mention of similar one-time inspections prior to entering into subsequent PEOs (i.e., LTO). Program Element 4 should be revised to specify a second one-time inspection prior to entering LTO.

4.2.32.4 Recommendations for Subsequent License Renewal

4.2.32.4.1 Good Practices or Strengths of AMP XI.M35

No specific good practice was identified during the review.

4.2.32.4.2 Areas of AMP XI.M35 for Further Consideration/Enhancement

Program Description:

M32.0-1: *Recommendation*: Ensure that a separate satisfactory AMP for the inspection of Class 1 small-bore piping is in place prior to entering LTO.
***Technical Basis*:** LRAs prepared under GALL, Rev. 0, guidance do not include a separate AMP for the inspection of Class 1 small-bore piping. Instead, the inspection of small-bore piping is typically included under the GALL, Rev. 0, One-Time Inspection Program XI.M32. However, overall OpE has shown that the cracking of small-bore piping is a widespread problem, and a separate AMP to manage this form of degradation is needed.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M32.4-1: *Recommendation*: Revise Program Element 4 wording to clarify program applicability to plants that have experienced cracking in small-bore piping.
***Technical Basis*:** GALL, Rev. 2, Program Element 4, "Detection of Aging Effects," states in the second sentence that "this inspection does not apply to those plants that have experienced

cracking due to stress corrosion, cyclical (including thermal, mechanical, and vibration fatigue) loading, or thermal stratification and thermal turbulence (MRP 146 and MRP 146S)." However, in the second paragraph of the same program element, the AMP states that "If the applicant has successfully mitigated any failures in its ASME Class 1 piping, the inspection should include 10% of the weld population or a maximum of 25 welds of each weld type…" In addition, in the second sentence of the second paragraph of the Program Description section, the AMP states, "This program can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking." This apparent contradiction concerning the applicability of AMP XI.M35 to plants that have experienced cracking needs to be clarified. It appears that the second sentence of Program Element 4 is either incorrect or is worded in such a way as to create confusion.

M32.4-2: *Recommendation*: Program Element 4 should be revised to explicitly specify a second one-time inspection prior to entering LTO.
***Technical Basis*:** Program Element 4, "Detection of Aging Effects," states in the last sentence of the second paragraph that "The one time inspection should be completed within the six year period prior to the period of extended operation." However, it makes no mention of similar one-time inspections prior to entering into subsequent PEOs (i.e., LTO).

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M32.10-1: *Recommendation*: Consider revising Program Element 10 to include plant OpE with cracking in small-bore piping.
***Technical Basis*:** NUREG/CR-6923 notes that, for piping in a number of systems, the fatigue failure of socket welds is a high-susceptibility item. This assessment is borne out by the OpE at several plants (e.g., Columbia). Though OpE is mentioned in the Program Description section of this AMP and in Program Element 4, Program Element 10 ("Operating Experience") mentions only experience with volumetric inspection techniques and makes no reference to plant-specific OpE concerning cracking in small-bore piping. Program Element 10 should be expanded to include reference to plant OpE with cracking in small-bore piping and its relevance to the applicability of this AMP.

4.2.33 External Surfaces Monitoring of Mechanical Components (XI.M36)

4.2.33.1 Objective and Scope of Rev. 2 AMP XI.M36

The External Surfaces Monitoring of Mechanical Components program is based on system inspections and walkdowns. This program consists of periodic visual inspections of metallic and polymeric components, such as piping, piping components, ducting, polymeric components, and other components within the scope of license renewal and subject to AMR in order to manage aging effects. The program manages aging effects through visual inspection of external surfaces for evidence of loss of material, cracking, and changes in material properties. When appropriate for the component and material, manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength. Loss of material due to boric acid corrosion is managed by the Boric Acid Corrosion program (AMP XI.M10).

This AMP relies on the requirements or guidance from the following documents:
(i) EPRI Technical Report 1007933, *Aging Assessment Field Guide*, December 2003;
(ii) EPRI Technical Report 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004; and
(iii) INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.

4.2.33.2 Observations from Ginna and NMP-1

The license renewal process for both Ginna and NMP-1 was carried out under the GALL Report, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was the AMP B2.1.33, “System Monitoring Program,” and that at NMP-1 was the “Systems Walkdown Program,” AMP B2.1.33.

Based on discussions with the Ginna personnel during the audit and the CRs made available, the program appears to be primarily concerned with the visual detection of leakage, rust and corrosion, and coating degradation on the external surfaces of accessible components. Further details are available in the AEA TLR, ML13122A009.

There were a large number of findings at Ginna during the first quarterly report for trending corrective action reports, but the number has declined significantly in the following quarterly reports and semi-annual trending reports that were reviewed during the audit. However, Ginna does not count corrective action reports if the condition has been previously observed and reported but not corrected. Its most predominant aging effect has been boric acid corrosion.

The Systems Walkdown Program at NMP-1 manages aging effects for accessible external surfaces. Further details are available in ML13122A009. For components accessible during operation, inspections are performed more frequently, apparently on a case-by-case basis. During the audit interview, NMP-1 personnel emphasized that the program involves visual inspection only and does not include, for example, manual probing and manipulation of elastomers or any other kinds of hands-on inspections. The licensee stated that, for most inaccessible components, the potential for the presence of degradation is inferred from observations on similar accessible components operating under the same environment.

The sort of degradation observed to date at NMP-1 has been relatively minor and is limited primarily to modest surface rust and corrosion and occasional small leaks. The licensee stated that degradation does not appear to be accelerating with time but is more or less steady state, though longer-term extended operation is needed to more accurately assess this trend. In one case, extensive rusting observed on the external surfaces of piping through visual inspection

was followed up with extensive UT examinations to verify that it was nothing more than a surface effect.

4.2.33.3 Effectiveness of AMP XI.M36 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.33, "AMP Worksheet XI.M36 External Surfaces Monitoring of Mechanical Components." The significant conclusions on the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.33.4.

4.2.33.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant conclusions from an assessment of the adequacy of the program description are as follows:

(a) The second paragraph of the Program Description for the parallel AMP XI.M38 ("Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components") states that, "This program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in loss of intended function. If OpE indicates that there have been repetitive failures caused by loss of material, a plant-specific program will be required. Following a failure, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest." Loss of material at the external surfaces of piping and ducts, which addressed by the current AMP, can also potentially result in loss of intended function. If such failures occur on a repetitive basis, similar limitations on the applicability of this AMP appear to be desirable, particularly for operating periods beyond 60 years. A revision of the program description wording should be considered.

The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was the System Monitoring Program, and that at NMP-1 was the Systems Walkdown Program. The Ginna Systems Monitoring Program does not state any exceptions or enhancements to GALL, Rev. 0, nor are any commitments identified. The NMP-1 Systems Walkdown Program takes no exceptions to GALL, Rev. 0, but it does identify two enhancements, as follows: (1) train all personnel performing inspections in the Systems Walkdown Program to ensure that age-related degradation is properly identified and incorporate this training into the site training program; and (2) specify acceptance criteria for visual inspections to ensure aging-related degradation is properly identified and corrected.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR. This could be an important factor and may be evaluated in future efforts.

4.2.33.3.2 Effectiveness and Implementation of AMP XI.M36

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant conclusions from the evaluation are as follows:

(a) Program Element 1, "Scope of Program," states that, "The program may also be credited with managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for situations in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program should describe the component internal environment and the credited similar external component environment inspected." The management of loss of material at internal surfaces is also mentioned in Program Element 4 of this AMP (see item [b] below). However, the parallel AMP XI.M38 ("Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components") already exists for the management of loss of material from internal surfaces. This text in the present AMP appears to create possible ambiguity as to which of these two AMPs is to be applied to managing aging degradation at internal surfaces. The text of Program Elements 1 and 4 should be changed to clarify program applicability with respect to internal surfaces.

(b) Program Element 4, "Detection of Aging Effects," states that this program is credited with managing several aging effects, including "loss of material for internal surfaces exposed to the same environment as the external surface." See remarks under item (a) above.

4.2.33.4 Recommendations for Subsequent License Renewal

4.2.33.4.1 Good Practices or Strengths of AMP XI.M36

M33.S-1: *Recommendation*: At NMP-1, extensive rusting observed on the external surfaces of piping was followed up with extensive UT examinations to verify that it was nothing more than a surface effect. This application of advanced inspection techniques to better characterize observations from visual inspections is considered a good practice or strength of the AMP.
***Technical Basis*:** Visual inspections are generally incapable of detecting volumetric degradation effects, and any suspicious visual observations should be followed up with more advanced volumetric inspection techniques to better characterize the nature of the degradation observed.

4.2.33.4.2 Areas of AMP XI.M36 for Further Consideration/Enhancement

<u>Program Description</u>:

M33.0-1: *Recommendation*: Review plant-specific AMPs prepared under previous GALL guidance and revise as necessary prior to entering LTO to conform to current GALL AMP XI.M36 guidance.
***Technical Basis*:** The license renewal process for a number of plants was completed while GALL, Rev. 0, was in effect, and this edition of the GALL Report does not contain AMP XI.M36; instead, it calls for a plant-specific program to manage the aging effects now covered in XI.M36.

The plant-specific programs developed under GALL, Rev. 0, do not necessarily conform to the scope and guidance contained in GALL, Rev. 2. For example, the NMP-1 Systems Walkdown Program does not include the manual manipulation of polymers to detect hardening called for under Program Element 3. These plant-specific programs should be reviewed and updated as necessary prior to entering LTO to conform to current GALL AMP XI.M36 guidance.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M33.4-1: ***Recommendation*:** Consider augmenting the inspection requirements for LTO, depending upon plant OpE.
***Technical Basis*:** As the plant continues to age, particularly upon and subsequent to entering LTO, degradation at the external surfaces may be expected to increase. There may be a need to supplement the visual inspections called for under the present AMP with enhanced techniques and/or to increase the inspection frequency as the plant continues to age. The continued OpE with respect to the relevant structures, systems, and components should be monitored to provide guidance on this.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

See Item M33.4-1 above.

4.2.34 Flux Thimble Tube Inspection (XI.M37)

4.2.34.1 Objective and Scope of Rev. 2 AMP XI.M37

The objective of this program is to manage the loss of material due to wear in the flux thimble tubes of bottom-mounted instrument systems for in-core neutron flux monitoring of PWRs. These tubes are made of cold-worked austenitic SS, with or without chrome-plating, and are part of the RCS pressure boundary. The wear of flux thimble tubes occurs at certain locations due to flow-induced vibrations, which are plant-specific, and the resulting wall-loss is highly location-dependent.

To ensure that the aging effects due to loss of material from wear of the flux thimble tubes will be adequately managed such that their intended functional integrity is maintained during the extended and LTO, the AMP relies on three AMAs: (i) periodic inspections with acceptable and qualified methods to detect and conservatively estimate the wall loss, (ii) evaluation of inspection results to determine the adequacy of inspection interval for each tube, and (iii) dispositioning of all flaws with technically justified acceptance criteria for tube failure or leakage.

For these AMAs, the AMP relies on the requirements or guidance from NRC IE Bulletin 88-09, “Thimble Tube Thinning in Westinghouse Reactors,” July 26, 1988.

4.2.34.2 Observations from Ginna

The GALL Report AMP XI.M37, “Flux Thimble Tube Inspection,” is not applicable to NMP-1 since it is a BWR. This program is implemented at Ginna as a plant-specific AMP B2.1.36, “Thimble Tube Inspection Program,” in its LRA. The implementation at Ginna uses NRC Bulletin 88-09, “Thimble Tube Thinning in Westinghouse Reactors,” July 26, 1988, as its basis, and it includes a license renewal commitment (No. 39, Appendix A of SER Report NUREG-1786) to include inspections for SCC and wear during each outage, since cracking due to SCC was previously detected in certain regions of the thimble tubes.

The GALL Report, Rev. 0, did not include this program, and Revisions 1 and 2 of the GALL Report address only the wear loss of the tube wall as the aging effect. Ginna’s implementation of the OpE and inspections for SCC/IGA (intergranular attack) is thus an enhancement to GALL Report AMP XI.M37. During the Ginna audit, the staff confirmed this OpE and that the licensee’s corrective action of periodic flushing of the thimble-tube-to-guide-tube annuli was an appropriate response to address this aging effect in addition to tube wear.

With regard to the wall loss due to wear as the aging effect managed under this AMP, the Ginna audit review of licensee’s inspection results described in its PBDs (1999-2008) indicated that the licensee had replaced five thimble tubes in four locations and that all thimble tubes show acceptable wear levels against the acceptance criteria. This is considered indicative of the AMP’s performance in identifying and managing this aging degradation process. The licensee provided the following information after the audit: during the 2011 RFO, all 36 thimble tubes, as well as seal table subcomponents, were replaced. The previous 304SS tubes were replaced with more SCC resistant 316SS, and the portions of the tubes that were susceptible to wear were chrome-plated to mitigate wear. With the completion of this modification, a commitment change was processed to change the thimble tube inspection frequency, beginning in 2014, to every 3rd RFO instead of every RFO.

4.2.34.3 Effectiveness of AMP XI.M37 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.37, "AMP Worksheet XI.M37 Flux Thimble Tube Inspection." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.34.4.

4.2.34.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The significant limitations of this program are not clear from the description: The program does not address cracking or cracking with volumetric (wall thinning) wear. The monitoring is only for detectable wall loss. An important attribute of this wall loss is that it is highly plant-specific and location-dependent.

4.2.34.3.2 Effectiveness and Implementation of AMP XI.M37

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 2, "Preventive Actions," provides no guidance on preventive measures that have been developed and/or used with technical basis for mitigation.

(b) Program Element 4, "Detection of Aging Effects," does not clarify the need, or include guidance, for verifying wear scar geometry effects on the detection and associated depth determination, or confirming at least minimally that no cracking is associated or identified as part of the detection.

(c) Program Element 5, "Monitoring and Trending," does not provide explicit guidance on the need for conservative determination and verification of the actual wear rate parameter vis-à-vis that expected based on the method in use, how to account for the uncertainty in it, and checking/baselining after change in operating conditions likely to affect the reactor core flow.

(d) Program Element 6, "Acceptance Criteria," lacks identification of a single or uniformly applicable (technically justified) acceptance criteria (basis) document formally reviewed and approved by the Staff.

(e) Program Element 10, “Operating Experience,” does not adequately address or cover the root causes of actual OpE events and leakages related to the flux thimble tube failures, nor does it provide a review of all related OpE, that especially confirming AMP adequacy or the need for revisions to manage the functionality of flux thimble tubes from all the identified aging degradation effects leading to the leakage event.

Many of the plant-specific programs/attributes or implementations of this GALL AMP have resulted in various commitments over the years. The AMP implemented by Ginna is plant-specific because its LRA was based on GALL, Rev. 0, which did not include the flux thimble tube inspection. The plant-specific AMP at Ginna has a commitment (#39) to include inspections for SCC and wear during each outage because SCC/IGA were previously detected in certain regions of thimble tube; the LRA noted that the entire length of each thimble tube will be inspected for SCC by eddy current examination. The adequacy of the GALL AMP in managing the combined SCC (or cracking) and wear degradations within the established criteria for inspection interval may need further evaluation – either confirmation of absence of cracking process, or further evaluation may be relevant in a consistency review.

The review of AMP implementations also pointed to the need for better assessment and communication with the Staff regarding any inconsistencies with the technical information originally submitted in the LRA or in response to requests for additional information (RAIs), which is also related to Part 50.59 requirements.

No good practices or strengths of the AMP were identified in this review.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.34.4 Recommendations for Subsequent License Renewal

4.2.34.4.1 Good Practices or Strengths of AMP XI.M37

No specific good practice was identified during the review.

4.2.34.4.2 Areas of AMP XI.M37 for Further Consideration/Enhancement

Program Description:

M34.0-1: *Recommendation*: Clarify significant limitations of this program that may need some consideration in a plant-specific manner, for example, the program does not address cracking or cracking with volumetric (wall thinning) wear as an aging effect, or that the monitored wall loss is highly plant-specific and location-dependent.
***Technical Basis*:** The program does not address or identify any other GALL AMP to manage cracking or cracking with volumetric (wall thinning) wear, when several forms of degradation or combined degradations including wear caused by the flow-induced vibrations can lead to leaks of this RCS boundary with potential for non-isolable leak and/or a multiple failures scenario.

1. Scope of Program:

No further review item identified.

2. <u>Preventive Action</u>:

M34.2-1: *Recommendation*: Provide guidance based on industry survey of mitigation measures and their performance record.
***Technical Basis*:** Flushing of the annulus between thimble tube and guide tube has been in use to reduce likelihood of SCC. A double-wall design for thimble tubes has been proposed/used to increase the safety margin against possible leakage incidence. Replacement with alternate wear-resistant material has been considered. At the same time, the effectiveness of thin chromium plating (much less than that can be detected if lost to local wear) for long inspection intervals and/or LTO needs to be examined and confirmed.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M34.4-1: *Recommendation*: Note that the identification and interpretation of detected degradation are subject to assumptions regarding wear-scar geometries so that the applicable NDE needs to confirm the requisite conservatism in such determination of the wear. Include some element or extent of the NDE as part of the detection activity to confirm the assumption that no cracking is associated or identified with the wear. Add a clarifying note about reporting requirements for detected degradation of thimble tubes.
***Technical Basis*:** The examination frequency is likely to be affected by the wear-scar geometries, which should be conservatively assessed with verification. The potential for the development of cracking with wearing cannot be ruled out. Cracking is the most likely mode of degradation, as opposed to tube collapse due to thinning, in several cases where leakage and its progression have been noted. The development of cracking can be due to fatigue or stress corrosion related. Some limited analysis of NDE data to confirm that only (volumetric) wear is occurring would support the AMP basis since, to ensure the functionality and pressure boundary of this component, it relies on the assumption that wear is the only active degradation. The NRC IE Bulletin 88-09 notes that the reporting requirements of 10 CFR 50.72 and 10 CFR 50.73 are applicable.

5. <u>Monitoring and Trending</u>:

M34.5-1: *Recommendation*: Clarify the need for projection methods to estimate and use technically justified conservative values of location-specific wear rates, and that the trending should be confirmed by comparing both the wear depths estimated with NDE uncertainty and the observed wear rates versus those projected by the plant-specific approach.
***Technical Basis*:** Some plant-specific implementations seem to apply conservatism on an average wear rate, either over number of inspection intervals or over the thimble population, or not account for discrepancies in projected and measured wear rates at all. The trending should explicitly account for any non-conservative discrepancies in the location-specific wear rate relevant to the inspection interval. Relatively large underestimation of data-based, as-found wear rate, at least on a location-specific basis, if not corrected in the projection methodology for the next inspection interval, has the potential to exceed the acceptance limit during service, especially when the remaining margin is not large enough relative to the inherent uncertainty of estimation. Confirmation of the conservatisms, especially for this condition monitoring program, should be an integral part of this program element for its implementation to be effective as intended for the PEO.

6. <u>Acceptance Criteria</u>:

M34.6-1: *Recommendation*: Revise the element description and recommend review for validated criteria basis. Any plant-specific use of an acceptance criterion should clearly state the applicable failure mode and technical justification for the limiting conditions of the acceptable wear; the technical justification should include the uncertainty in application of the criterion and an acceptable safety margin for the allowable remaining thickness. These elements of the acceptance criterion are independent of the other uncertainty sources such as the NDE measurement and wear-scar geometry assumptions.
***Technical Basis*:** There is no single or uniformly applicable (technically justified) acceptance criteria (basis) document formally reviewed and approved by the Staff. In addition, any uncertainty in a validated criterion itself should be specified for that criterion. This should not be commingled with other sources of uncertainty that are independent of the acceptance criteria; any improvements or changes in the other sources of uncertainty, which may be plant specific, may become confounded and/or not properly accounted for. Acceptance criteria are specific to both the type of degradation (and its aging effect) and the presumed mode of (final) failure (whether it is tube collapse, or brittle fracture, or buckling, etc.). These should be clearly specified and limited as stated. Acceptable and technically justified uncertainty in the criteria needs to be specified and treated independently of other sources of uncertainty, in addition to the requirement for an adequate margin of safety.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M34.10-1: *Recommendation*: Add summary and root causes of actual OpE events and leakages through the years since the early 1980s and the recent past. Perform a comprehensive review of all related OpE to confirm AMP adequacy or need for revision to manage the functionality of flux thimble tubes from all the identified aging degradation effects leading to the leakage.
***Technical Basis*:** Multiple repositioning, discounting of locally high wear rate, not fully accounting for all sources of uncertainty in the wear projections, and not confirming wear (general wall loss) to be the only active degradation (to the exclusion of any cracking) are some of the issues identified in related OpE exceptions (some even after two decades of existing programs). The industry-wide experience in recent years (e.g., as referenced in the SERs for the Farley and Diablo Canyon LRAs) has demonstrated the need to limit the tube repositioning actions and to better evaluate the inspection data in confirming the assumed conservatism in the wear projections. The OpE also suggests the need for a limited inspection activity to confirm that cracking is not present in addition to the wear detection. In addition, several instances of thimble tube leakage and cracking have been noted, some within the first period after inspection, that have not been well characterized or fully reviewed for examining the

applicability or effectiveness of this AMP for future avoidance. If the plant-specific OpE, or its generic nature, indicates the applicability of cracking (SCC, fatigue, etc.), the AMP should include inspections to detect and manage the cracking and resulting leakage failure of the thimble tubes, which are highly cold-worked and highly irradiated components of the RCPB.

4.2.35 Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (XI.M38)

4.2.35.1 Objective and Scope of Rev. 2 AMP XI.M38

The program consists of inspections of the internal surfaces of metallic piping, piping components, ducting, polymeric components (including HDPE), and other components that are exposed to air indoor uncontrolled, air outdoor, condensation, and any water system other than OCCW system (XI.M20), closed treated water system (XI.M21A), and fire water system (XI.M27). These internal inspections are performed during the periodic system and component surveillances or during the performance of maintenance activities when the surfaces are made accessible for visual inspection. The program includes visual inspections to ensure that existing environmental conditions are not causing material degradation that could result in a loss of component intended functions. For certain materials, such as polymers (including HDPE), physical manipulation or pressurization (e.g., hydrotesting) to detect hardening or loss of strength should be used to augment the visual examinations conducted under this program. If visual inspection of internal surfaces is not possible, then the applicant needs to provide a plant-specific program.

This program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in loss of intended function. If OpE indicates that there have been repetitive failures caused by loss of material, a plant-specific program will be required. Following a failure, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest.

This AMP relies on the requirements or guidance from the following documents:
(i) EPRI Technical Report 1007933, *Aging Assessment Field Guide*, December 2003;
(ii) EPRI Technical Report 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004; and
(iii) INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.

4.2.35.2 Observations from Ginna and NMP-1

The license renewal process for both Ginna and NMP-1 was carried out under the GALL Report, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was AMP B2.1.23, “Periodic Surveillance and Preventive Maintenance,”, and that at NMP-1 was AMP B2.1.32, “Preventive Maintenance Program.” Further details are available in the AEA TLR, ML13122A009.

There has been only one significant adverse finding at NMP-1, and that was in a retired/abandoned-in-place component in which the pump casing and connections showed signs of corrosion. The pump is to be disconnected so it will no longer be in the scope of license renewal. Corrosion of some pump coatings has also been observed, and these coatings have been replaced. If similar corrosion is observed on inspections of similar pumps, the inspection sample population size will be increased.

During the NMP-1 audit, the plant owner of the program stated that he maintains a detailed set of spreadsheets to track any changes with time. The inspection frequency is largely dictated by

the plant's 2-year refueling cycle, and, as noted above, inspection sample sizes and techniques employed appear to be based on the results of previous inspections and observed trends.

The Ginna program has produced a number of condition reports from the inspections, and observations from these reports are fed back to their respective programs. When significant corrosion or other degradation is observed, the inspection frequency is increased. A significant number of pipe replacements have resulted from observations in this program.

4.2.35.3 Effectiveness of AMP XI.M38 to Meet Its Objective

The preliminary audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. There were no separate preliminary AEA reports for XI.M38. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.35, "AMP Worksheet XI.M38 Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.35.4.

4.2.35.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was the Periodic Surveillance and Preventive Maintenance Program, and that at NMP-1 was the Preventive Maintenance Program. The Ginna Periodic Surveillance and Preventive Maintenance Program lists no exceptions to GALL, but it states under Program Elements 3 ("Parameters Monitored/Inspected"), 4 ("Detection of Aging Effects"), and 6 ("Acceptance Criteria") that "Operations, maintenance, and surveillance test procedures and task descriptions will be enhanced to provide explicit guidance on detection of applicable aging effects and assessment of degradation." The NMP-1 Preventive Maintenance Program takes no exceptions to GALL, Rev. 0, but it identifies the following enhancements: (1) expand the Part Monitoring Program to encompass activities for certain additional components, identified as requiring aging management, and explicitly define the aging management attributes, including the systems and the component types/commodities included in the program; (2) specifically list those activities credited for aging management; (3) specifically list parameters monitored; (4) specifically list the aging effects detected; (5) establish a requirement that inspection data be monitored and trended; and (6) establish detailed parameter-specific acceptance criteria.

During the license renewal process, NMP committed to making enhancements to the Preventive Maintenance Program to revise existing procedures. These enhancements would provide the level of detail and specificity needed for Staff review of the Preventive Maintenance Program. They would affect the main program elements including “Scope of Program,” “Preventive Actions,” “Parameters Monitored,” “Detection of Aging Effects,” “Monitoring and Trending,” and “Acceptance Criteria.” At the request of the NRC staff, these enhancements were to be completed on a schedule of sufficient time for staff review and approval prior to the PEO.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.35.3.2 Effectiveness and Implementation of AMP XI.M38

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1 in the parallel AMP XI.M36, “External Surfaces Monitoring of Mechanical Components” states that “The program may also be credited with managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for situations in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program should describe the component internal environment and the credited similar external component environment inspected.” The management of loss of material at internal surfaces is also mentioned in Program Element 4 of AMP XI.M36. However, the current AMP XI.M38 (“Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components”) already exists for the management of loss of material from internal surfaces. The wording of Program Elements 1 and 4 in AMP XI.M36 and, if necessary, in the current AMP, need to be revised to clarify program applicability with respect to internal surfaces.

4.2.35.4 Recommendations for Subsequent License Renewal

4.2.35.4.1 Good Practices or Strengths of AMP XI.M38

M35.S-1: ***Recommendation*****:** During the NMP-1 audit, the program owner of the Preventive Maintenance Program stated that he maintains a detailed set of spreadsheets through which he tracks any changes with time. The inspection frequency is largely dictated by the plant’s 2-year refueling cycle, and inspection sample sizes and inspection techniques employed appear to be based on the results of previous inspections and observed trends. This method trending and responding to previous findings is considered a good practice or strength of the AMP.
Technical Basis**:** Detailed trending of inspection findings and the development of subsequent inspection procedures based on the observed trends provides an opportunity for continued program improvement. This is in keeping with the intent of GALL AMP XI.M38 Program Element 5, “Monitoring and Trending.”

4.2.35.4.2 Areas of AMP XI.M38 for Further Consideration/Enhancement

Program Description:

M35.0-1: ***Recommendation*:** Review plant-specific AMPs prepared under previous GALL guidance and revise as necessary prior to entering LTO to conform to current GALL AMP XI.M38 guidance.
***Technical Basis*:** The license renewal process for a number of plants was completed while GALL, Rev. 0, was in effect. This edition of the GALL Report does not contain AMP XI.M38; instead, it calls for a plant-specific program to manage the aging effects now covered in XI.M36. The plant-specific programs developed under GALL, Rev. 0, do not necessarily conform to the scope and guidance contained in GALL, Rev. 2. These plant-specific programs should be reviewed and updated as necessary prior to entering LTO to conform to current GALL AMP XI.M38 guidance.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. <u>Operating Experience</u>:

M35.10-1: *Recommendation*: Critically review OpE prior to entering LTO to assess the effectiveness of existing condition monitoring AMPs.
***Technical Basis*:** Although the OpE suggests that the Ginna Periodic Surveillance and Preventive Maintenance Program is effective in detecting aging degradation, the large number of corrective actions that have been initiated since the plant began operation indicates that the mitigation measures to prevent degradation may not be effective or that the frequency for inspection and/or performance monitoring are not adequate. The Action Reports and the root cause evaluations should be reviewed to identify which aging effects/mechanisms and components/systems combinations are associated with these reports. In addition, check whether the current operations, maintenance, and surveillance test procedures and plant work orders were enhanced to provide explicit guidance on detection of applicable aging effects and assessment of degradation, and if they were, what actions were taken and whether these actions were effective in enabling the timely detection of aging degradation.

4.2.36 Lubricating Oil Analysis (XI.M39)

4.2.36.1 Objective and Scope of Rev. 2 AMP XI.M39

The purpose of the Lubricating Oil Analysis program is to ensure that the oil environment in the mechanical systems is maintained to the required quality to prevent or mitigate age-related degradation of components within the scope of this program. This program maintains oil systems contaminants (primarily water and particulates) within acceptable limits, thereby preserving an environment that is not conducive to loss of material or reduction of heat transfer. Lubricating oil testing activities include sampling and analysis of lubricating oil for detrimental contaminants. The presence of water or particulates may also be indicative of in-leakage and corrosion product buildup.

Although primarily a sampling program, the lubricating oil analysis program is generally effective in monitoring and controlling impurities. This report identifies when the program is to be augmented to manage the effects of aging for license renewal. Accordingly, in certain cases identified in this report, verification of the effectiveness of the program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the PEO. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system.

This AMP relies on the requirements or guidance from the following document:
(i) ASTM D 6224-02, *Standard Practice for In-Service Monitoring of Lubricating Oil for Auxiliary Power Plant Equipment*, 2002.

4.2.36.2 Observations from Ginna and NMP-1

The license renewal process for both Ginna and NMP-1 was carried out under the GALL Report, Rev. 0. That edition of the GALL Report mentions lubricating oil with contaminants and/or moisture as a possible operating environment for several components, but it contains no AMP-related to Lubricating Oil Analysis. Consequently, neither the Ginna LRA nor the NMP-1 LRA provides an AMP on Lubricating Oil Analysis. The Ginna LRA mentions the aging management of oil coolers in the auxiliary FW system in contact with contaminated lubricating oil and lists its Periodic Surveillance and Preventive Maintenance program as the applicable AMP. The NMP LRA lists a number of components in contact with lubricating oil, but makes no mention of possible contamination and identifies no aging effect.

No audits of AMPs dealing with lubricating oil analysis were conducted at Ginna or NMP-1.

4.2.36.3 Effectiveness of AMP XI.M39 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.36, "AMP Worksheet XI.M39 Lubricating Oil Analysis." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The

recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.36.4.

4.2.36.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.36.3.2 Effectiveness and Implementation of AMP XI.M39

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

4.2.36.4 Recommendations for Subsequent License Renewal

4.2.36.4.1 Good Practices or Strengths of AMP XI.M39

No specific good practice was identified during the review.

4.2.36.4.2 Areas of AMP XI.M39 for Further Consideration/Enhancement

Program Description:

M36.0-1: ***Recommendation*:** Revise the wording in the program description to explicitly state that a one-time inspection must be carried out prior to entering each PEO (i.e., another one-time inspection is required prior to license extension beyond 60 years).
***Technical Basis*:** The Program Description section of this AMP states, "in certain cases identified in this report, verification of the effectiveness of the program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the PEO. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system." However, it makes no mention of inspection requirements prior to entering subsequent periods of extended operation (i.e., LTO).

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.37 Monitoring of Neutron Absorbing Materials Other than Boraflex (XI.M40)

4.2.37.1 Objective and Scope of Rev. 2 AMP XI.M40

The objective of this program is to provide AMAs for managing the aging effects in the spent fuel pool using neutron-absorbing materials other than Boraflex (e.g., Boral, Metamic, boron steel, and carborundum). The aging effects include reduction of neutron-absorbing capacity, changes of dimension that increase K_{eff}, and loss of material due to neutron-absorber degradation and radiation. To ensure that the aging effects are managed in the PEO, the AMP relies on the following AMAs:

(1) Performing periodic coupon testing, direct in-situ testing, or both for verification of boron loss through areal density measurement of coupons or through direct in situ techniques, such as measurement of boron areal density, measurement of geometric changes in the material (blistering, pitting, and bulging), and detection of gaps through blackness testing. The frequency of the inspection and testing depends on the condition of the neutron-absorbing material and is determined and justified with plant-specific OpE by the licensee, not to exceed 10 years.

(2) The parameters monitored include the physical condition of the neutron-absorbing materials, such as in-situ gap formation, geometric changes in the material (formation of blisters, pits, and bulges) as observed from coupons or in situ, and decreased boron areal density. The parameters monitored are directly related to determination of the loss of material or loss of neutron absorption capability of the material(s).

The AMP is developed based on NRC LR-ISG-2009-01, “Aging Management of Spent Fuel Pool Neutron-Absorbing Material Other Than Boraflex.” NRC IN 2009-26, “Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool” addresses the issue of degradation of the carborundum neutron-absorbing materials in the spent fuel pools and the deformation of Boral panels in spent fuel pools.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) NRC LR-ISG-2009-01 and NRC IN 2009-26.

4.2.37.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.30, “Spent Fuel Pool Neutron Absorber Monitoring,” which is similar in scope to AMP XI.M40 of the GALL Report, Rev. 2, “Monitoring of Neutron-Absorbing Materials Other Than Boraflex.” Ginna uses soluble boron and borated stainless steel for neutron absorption; existing Boraflex in the SFP is not credited and thus is not age-managed. Ginna’s B2.1.30 AMP monitors long-term performance of the borated stainless steel (BSS) panels using surveillance coupons comprised of the same material. As stated above, Ginna also incorporates Boraflex panels in the SFP. However, reliance on the neutron absorption capability of the Boraflex panels was discontinued when the NRC approved License Amendment 79 on December 7, 2000.

Ginna’s program uses BSS coupons mounted on a surveillance tree in the SFP. These samples are removed for visual examinations for signs of corrosion or blistering, and physical measurements of thickness and weight, for comparison to pre-operational photographs of surface condition and measurements. Samples are removed, examined, and returned to the surveillance tree every three refueling outages, by “qualified personnel.” The BSS coupon samples have been examined in 2000, 2006, and 2010, and no degradation was found in any

evaluated parameter. The visual and quantitative observations have identified no changes from the pre-operational conditions. Ginna has reviewed the NRC Information Notice (IN) 2009-26, "Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool," and determined that no changes were needed in the AMP.

As stated in Section 2.3.21, the NMP-1 SFP had eight Boraflex racks in its SFP. Only two racks made of Boraflex currently exist in the NMP-1 SFP. Two re-rack campaigns were performed in 1999 and 2004, which replaced most of the original Boraflex and non-poison racks with Boral racks. NMP-1 credits its existing AMP B2.1.12, "Boraflex Monitoring Program," for managing aging effects of Boraflex racks; however, the Boral racks are monitored based on a specific commitment made to the NRC during the licensing of the rack expansion and redesign to the use of Boral. Findings and evaluation of NMP-1's "Boraflex Monitoring Program" AMP are contained in Section 2.1.21, XI M22, "Boraflex Monitoring," of ML13122A009.

4.2.37.3 Effectiveness of AMP XI.M40 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.37, "AMP Worksheet XI.M40 Monitoring of Neutron Absorbing Materials Other Than Boraflex." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.40.4.

4.2.37.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description needs to distinguish the AMP from XI.M22, Boraflex Monitoring. It also needs more details from LR-ISG-2009-01, which forms the basis of the AMP.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with GALL AMP XI.M40.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.2.37.3.2 Effectiveness and Implementation of AMP XI.M40

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) SER (NUREG 1900) Section 3.0.3.2.9 of NMP-1 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels.

Because the NMP-1 spent fuel pool has both Boraflex and Boral panels, the AMP needs to provide guidance on the applicability of program elements such as detection of aging effects, acceptance criteria in a spent fuel pool that contains both Boraflex, and neutron-absorbing materials other than Boraflex.

4.2.37.4 Recommendations for Subsequent License Renewal

4.2.37.4.1 Good Practices or Strengths of AMP XI.M40

No specific good practice was identified during the review.

4.2.37.4.2 Areas of AMP XI.M40 for Further Consideration/Enhancement

Program Description:

M37.0-1: *Recommendation*: Add following statements extracted from LR-ISG-2009-01 to the program description:
"Many neutron-absorbing materials, such as Boraflex, Boral, Metamic, boron steel, and carborundum, are used in spent fuel pools. XI.M22, Boraflex Monitoring, address aging management of spent nuclear pools using Boraflex as a neutron-absorbing material. This AMP address aging management of spent nuclear pools using materials other than Boraflex, such as Boral, Metamic, boron steel, and carborundum.
Recent OpE indicates several instances of degradation and/or deformation of neutron-absorbing materials other than Boraflex in the spent fuel pools of operating reactors, as described in NRC IN 2009-26, "Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool."
This program assures that degradation of spent fuel pool neutron-absorbing materials other than Boraflex that could compromise the criticality analysis will be detected in the PEO. The aging effects of the reduction of neutron-absorbing capacity, changes in dimension that increase K_{eff}, and loss of material due to neutron-absorber degradation and radiation are managed by coupon testing, direct in-situ testing, or both. Such testing includes periodic verification of boron loss through areal density measurement of coupons or through direct in-situ techniques, such as measurement of boron areal density, measurement of geometric changes in the material (blistering, pitting, and bulging), and detection of gaps through blackness testing."
***Technical Basis*:** The program description needs to distinguish itself from XI.M22 Boraflex Monitoring. It also needs more details from LR-ISG-2009-01, which forms the basis of the AMP.

1. Scope of Program:

M37.1-1: *Recommendation*: Expanding the Scope of Program as follows: "The AMP manages the effects of aging on neutron-absorbing components/materials other than Boraflex (e.g., Boral, Metamic, boron steel, and carborundum) in the spent fuel pools.
Aging effects include reduction of neutron-absorbing capacity, changes of dimension that increase Keff, and loss of material due to neutron-absorber degradation and radiation."
Technical Basis: The program element does not mention what the aging effects and materials of neutron-absorbing materials are.

2. Preventive Action:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

M37.3-1: *Recommendation*: Add a statement such as the following: "The parameters monitored/inspected also include aluminum concentration, blistering, and loss of plate-type carborundum material, because these aging effects have occurred in industry OpE."
Technical Basis: The OpE of this AMP states that the applicant's monitoring program should be capable of detecting aluminum concentration, blistering, and loss of plate-type carborundum material that have occurred in industry OpE.

4. <u>Detection of Aging Effects</u>

M37.4-1: *Recommendation*: Add guidance on the applicability of the program element in a spent fuel pool that contains both Boraflex and neutron-absorbing materials other than Boraflex. For example, the GALL Report states that the frequency of inspection and testing depends on the condition of the neutron-absorbing material and is determined and justified with plant-specific OpE by the licensee, not to exceed 10 years. It needs to clarify that the 10-year inspection frequency is still valid in a spent fuel pool that contains both Boraflex and materials other than Boraflex.
Technical Basis: SER (NUREG 1900) Section 3.0.3.2.9 states that NMP-1 is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels. The NMP-1 spent fuel pool has both Boraflex and Boral panels.
This AMP may need some guidelines on its applicability in a spent fuel pool that contains both Boraflex and materials other than Boraflex. Note that aging management of Boraflex is addressed in XI.M22, Boraflex Monitoring.

M37.4-2 *Recommendation*: Add a statement such as the following: "The program also should be capable of detecting aluminum concentration, blistering, and loss of plate-type carborundum material, because these aging effects have occurred in industry OpE."
Technical Basis: The OpE of this AMP states that the applicant's monitoring program should be capable of detecting aluminum concentration, blistering, and loss of plate-type carborundum material that have occurred in industry OpE.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M37.6-1: *Recommendation*: Guidance should be provided on the acceptance criteria for spent fuel racks for a spent pool containing both Boraflex and non-Boraflex neutron-absorbing materials.
Technical Basis: SER (NUREG 1900) Section 3.0.3.2.9 states that NMP-1 is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels. Because the NMP-1 spent fuel pool has both Boraflex and Boral panels, the AMP needs to provide guidance and clarification on whether the acceptance criteria of 5% subcriticality margin of the spent fuel racks is still valid for a spent fuel pool containing both Boraflex and non-Boraflex Boral neutron-absorbing materials.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.2.38 Buried and Underground Piping and Tanks (XI.M41)

4.2.38.1 Objective and Scope of Rev. 2 AMP XI.M41

This is a comprehensive program designed to manage the aging of the external surfaces of buried and underground piping and tanks and to augment other programs that manage the aging of internal surfaces of buried and underground piping and tanks. It addresses piping and tanks composed of any material, including metallic, polymeric, cementitious, and concrete materials. This program manages aging through preventive, mitigative, and inspection activities. It manages all applicable aging effects, including loss of material, cracking, and changes in material properties.

Depending on the material, preventive and mitigative techniques may include the material itself, external coatings for external corrosion control, the application of cathodic protection, and the quality of backfill utilized. In addition, depending on the material, inspection activities may include electrochemical potential measurements to verify the effectiveness of cathodic protection, NDE of pipe or tank wall thicknesses, hydrotesting of the pipe, and visual inspections of the pipe or tank from the exterior as permitted by opportunistic or directed excavations.

Management of aging of the internal surfaces of buried and underground piping and tanks is accomplished through the use of other AMPs (e.g., Open Cycle Cooling Water System [AMP XI.M20], Closed Treated Water System [AMP XI.M21A], Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components [AMP XI.M38], Fuel Oil Chemistry [AMP XI.M30], Fire Water System [AMP XI.M27], or Water Chemistry [AMP XI.M2]). However, in some cases, this external surface program may be used in conjunction with the internal surface AMPs to manage the aging of the internal surfaces of buried and underground piping and tanks. This program does not address selective leaching. The Selective Leaching of Materials (AMP XI.M33) program is applied in addition to this program for applicable materials and environments.

The terms “buried” and “underground” are fully defined in Chapter IX of the GALL Report. Briefly, buried piping and tanks are in direct contact with soil or concrete (e.g., a wall penetration). Underground piping and tanks are below grade but are contained within a tunnel or vault such that they are in contact with air and are located where access for inspection is restricted.

This AMP relies on the requirements or guidance from the following documents:
(i) AASHTO R 27, *Standard Practice for Assessment of Corrosion of Steel Piling for Non Marine Applications*, 2006;
(ii) ASME Boiler and Pressure Vessel Code, Section IX, 2004;
(iii) NACE Recommended Practice RP0285-2002, *Standard Recommended Practice Corrosion Control of Underground Storage Tank Systems by Cathodic Protection,* revised April 2002;
(iv) NACE Standard Practice SP0169-2007, *Control of External Corrosion on Underground or Submerged Metallic Piping Systems*, 2007;
(v) NFPA Standard 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2010 edition; and
(vi) NFPA Standard 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2008 edition.

4.2.38.2 Observations from Ginna and NMP-1

This program is implemented at Ginna through AMP B2.1.7, “Buried Piping and Tanks Inspection,” and AMP B2.1.28, “Buried Piping and Tanks Surveillance.” = Ginna relies on its Periodic Surveillance and Preventive Maintenance program to carry out inspections of underground piping and tanks, and these inspections are performed on an opportunistic basis. No directed periodic inspections are indicated in the Ginna AMP, and this was confirmed by the Ginna program owner during the audit interview. However, the NMP-1 LRA includes a commitment to excavate degradation-susceptible areas to perform focused inspections if an opportunistic inspection has not occurred within the past 10 years at the time of initial license renewal.

NMP-1 implements this program through its AMP B2.1.22 “Buried Piping and Tanks Inspection Program”. The program includes a requirement that before entry into the PEO, if an opportunistic inspection has not occurred within the past ten years, NMP-1 will excavate degradation-susceptible areas to perform focused inspections. The program was initially established due to license renewal requirements, and has been expanded in response to industry issues related to buried-piping components. A new procedure NEP-BPT-INSP-01, Rev. 0, “Buried Piping and Tanks Inspection Program” was created in 2007 to provide instructions for implementing the LR Buried Piping and Tanks Inspection Program at NMP-1.

Further details of both the Ginna and NMP-1 programs are available in the AEA TLR, ML13122A009.

A visual inspection of a hydrant, standpipe, and its associated buried isolation valve at NMP-1 was completed in 2007. The piping was asbestos cement material. The inspection found the piping to be in exceptionally good condition with no aging effects noted. Soil samples that came into contact with the various components were taken and analyzed, and the corrosion potential was found to be low for the cement pipe and moderate for the steel pipe. The inspection team identified that this inspection location was not a high-risk location because it was above the water table.

In September 2011, a CR was initiated due to a failure of a buried city water cement/asbestos pipe at NMP-1. The event was determined to be a singular random event failure due to foreign object impingement on the piping (large rock in original construction backfill that impinged on piping due to excessive overhead loading during the past heavy haul movements). In addition, DER2003-1319, “Overall Assessment of the Significant of Nine Mile Point Fire Water System Corrosion,” identified piping and valve corrosion and leaks in several areas as a result of internal piping degradation. None of the defects found represented an impending failure of fire water system piping or valves.

4.2.38.3 Effectiveness of AMP XI.M41 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.38, “AMP Worksheet XI.M41 Buried and Underground Piping and Tanks.” The significant conclusions on the

adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.38.4.

4.2.38.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.M24, with exceptions and enhancements. The Ginna Buried Piping and Tanks Inspection AMP and Buried Piping and Tanks Surveillance AMP do not state any exceptions or enhancements to GALL, Rev. 0, nor are any commitments identified. After Ginna clarified that the inspection of buried tanks and piping is carried out under the Ginna One-Time Inspection Program, the NRC staff found the Ginna Buried Piping and Tanks Inspection Program to be acceptable. The Buried Piping and Tanks Surveillance Program was found to be acceptable as submitted in the LRA.

The NMP-1 Buried Piping and Tanks Inspection AMP identifies no exceptions or enhancements to GALL, Rev. 0, AMP XI.M34. The following commitment is stated: “Develop and implement a Buried Piping and Tank Inspection Program which includes a requirement that if an opportunistic inspection does not occur within the first ten years of extended operation, NMPNS will excavate a representative sample for the purpose of inspection.” This commitment is to be met prior to entering the PEO.

In response to an RAI concerning nuclear-power-demonstration–focused inspection only during the 10-year PEO and not during the 10-year period prior to extended operation, NMP responded that that its Buried Piping and Tanks Inspection Program was incomplete and that the amended LRA will be amended to address the need for possible focused inspections during the 10-year period prior to extended operation. With this clarification, the NRC staff found the NMP Buried Piping and Tanks Inspection AMP to be acceptable.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR. This could be an important factor for consideration in future efforts.

4.2.38.3.2 Effectiveness and Implementation of AMP XI.M41

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

4.2.38.4 Recommendations for Subsequent License Renewal

4.2.38.4.1 Good Practices or Strengths of AMP XI.M41

No specific good practice was identified during the review.

4.2.38.4.2 Areas of AMP XI.M41 for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M38.4-1: ***Recommendation*:** Verify inspection intervals for underground piping and tanks before entering LTO and during LTO.
***Technical Basis*:** According to the Ginna SER, Section 3.3.2.3.1, Ginna relies on its Periodic Surveillance and Preventive Maintenance Program to carry out inspections of underground piping and tanks, and these inspections are performed on an opportunistic basis. No directed periodic inspections are indicated in the Ginna AMP, and this was confirmed by the Ginna program owner during the audit interview. (Note, however, that the NMP-1 LRA includes a commitment to excavate degradation-susceptible areas to perform focused inspections if an opportunistic inspection has not occurred within the past 10 years at the time of initial license renewal.) The current AMP XI.M41 calls for directed inspections at 10-year intervals, beginning 10 years prior to entering into the initial PEO. Before entering LTO, as well as during LTO, it will be necessary to confirm that directed inspections have been performed at the intervals specified in current GALL guidance.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

No further review item identified.

4.2.39 Fatigue Monitoring (TLAA X.M1)

4.2.39.1 Objective and Scope of Rev. 2 TLAA X.M1

The program monitors and tracks the number of critical thermal and pressure transients for a set of selected components to ensure that the CUF (cumulative usage factor) for any component location, including the effects of the reactor coolant environment, does not exceed the design limit value of 1, at which point fatigue crack initiation is assumed for the component location. Furthermore, the program also verifies that the severity of the monitored transients is bounded by the design transient definition for which they are classified.

The effects of the reactor coolant environment on component fatigue life are addressed by determining an environmental fatigue life correction factors, for a set of sample critical reactor coolant pressure boundary components. Examples of critical components are identified in NUREG/CR-6260. Furthermore, SRP-LR (NUREG-1800, Rev. 2) states that applicants should add additional plant-specific component locations if they may be more limiting than those considered in NUREG/CR-6260.

Environmentally adjusted CUFs for the critical components may be evaluated using one of the following sets of expressions: (a) those provided in NUREG/CR-6583 for carbon and low-alloy steels and NUREG/CR-5704 for austenitic SSs, and using the applicable ASME Section III fatigue design curves; (b) those provided in Appendix A of NUREG/CR-6909 for carbon and low-alloy steels, austenitic SSs, and nickel alloy materials, and using either the applicable ASME Section III fatigue design curves or the fatigue design curves provided in NUREG/CR-6909 for carbon and low alloy steels and austenitic SSs (Figs. A.1, A.2, and A.3 and Tables A.1 and A.2 of NUREG/CR-6909); or (c) a Staff-approved alternative methodology. Note that any one option may be used for calculating the environmentally adjusted CUF for each material, and in Option (b), the CUF for nickel alloy materials is determined using the fatigue design curve for austenitic SS.

The program also recommends that, as discussed in NRC RIS 2008-30, the use of certain simplified analysis methodologies to demonstrate compliance with the ASME Code fatigue acceptance criteria could be non-conservative; therefore, the Staff requested applicants to perform confirmatory analysis to demonstrate that any simplified analyses provide acceptable results. For example, when the Green's (or influence) function is used to calculate fatigue usage during plant transient operations, such as startups and shutdowns the concern is in regards to the use of a single stress term for the evaluation of actual plant transients instead of detailed stress analysis, which requires consideration of six stress components, as discussed in ASME Code Section III, Subsection NB-3200. AA confirmatory analysis of a BWR feedwater nozzle indicated that a simplified input for the Green's function did not produce conservative results in the nozzle bore area when compared to detailed analysis.

The Fatigue Monitoring AMP relies on the requirements or guidance from the following documents:

(i) NRC RIS 2008-30, *Fatigue Analysis of Nuclear Power Plant Components*, December 16, 2008;
(ii) NUREG/CR-5704, *Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels*, April 1999;
(iii) NUREG/CR-6260, *Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components*, March 1995;

(iv) NUREG/CR-6583, *Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels*, March 1998; and
(v) NUREG/CR-6909, *Effects of LWR Coolant Environments on the Fatigue Life of Reactor Materials*, February 2007.

4.2.39.2 Observations from Ginna and NMP-1

The NMP-1 Fatigue Monitoring Program (FMP) is an existing program that manages cracking due to the cyclic fatigue of carbon steel, low alloy steel, stainless steel, and nickel alloy components. Further details are available in the AEA TLR, ML13122A009.

In 1999, prior to submitting the LRA, the NMP engineering personnel discovered that several transients affecting the NMP-1 reactor pressure vessel recirculation inlet and outlet nozzles were not required to be tracked per the FMP. An analysis of the fatigue effects of these additional cycles was performed and the fatigue usage contribution of the cycles was found to be relatively small. However, these seven transients have been added to the list of transients that must be tracked for NMP-1.

The OpE at NMP-1 showed that cracking was detected in a FW nozzle in 1977. The NMP-1 and industry experience on FW nozzle cracking has demonstrated the potential of this location to accumulate significant fatigue usage during plant operation. The staff noted that the licensee's use of stress-based fatigue methodology for the FW nozzle is adequate for calculating fatigue usage factors for the component, based on its heavy fatigue duty and past cracking experience. The staff also noted that a self-assessment of the FMP indicated that, in 2009, the recirculation nozzles were reanalyzed satisfactorily using all six directional stressors as input to the Green's Theorem portion of the overall fatigue analysis algorithm (addressing the NRC concerns in RIS 2008-30) and the cumulative usage factor (CUF) was less than 1.0 as required by the ASME code.

The FMP at Ginna is consistent with Section X.M1 of the GALL Report, "Metal Fatigue of Reactor Coolant Pressure Boundary." Further details are available in ML13122A009.

4.2.39.3 Effectiveness of TLAA X.M1 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.39, "AMP Worksheet X.M1 Fatigue Monitoring." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.2.39.4.

4.2.39.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description does not clarify whether this AMP is limited to the reactor coolant pressure boundary (RCPB) components as stated in the GALL Report, Rev. 1, or it includes those components that have been identified to have a fatigue TLAA as described in the scope of program in the GALL Report, Rev. 2.

(b) The SRP-LR recommends that the sample of critical locations for which environmental effects need be evaluated include, as a minimum, the locations evaluated in NUREG/CR-6260; the applicant should consider adding additional locations that are considered to be more limiting. However, it does not provide any criteria for selecting these additional locations, including a threshold value of fatigue CUF that constitutes high-fatigue usage.

(c) Earlier revisions of the SRP-LR report did not include any expressions for calculating the environmental fatigue life correction factor, F_{en}, for nickel alloy materials. It is not clear how the recommendations in SRP-LR, Rev. 2, are to be applied to the components that were reviewed under previous revisions of SRP-LR.

4.2.39.3.2 Effectiveness and Implementation of TLAA X.M1

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 1, “Scope of Program,” does not acknowledge that licensees who may have referenced some BWRVIP documents in their AMPs have to address the AAIs associated with the BWRVIP documents, including AAIs that involve fatigue TLAAs.

(b) Program Elements 1, “Scope of Program,” and 4, “Detection of Aging Effects,” do not provide adequate guidance to verify that all fatigue-sensitive locations are identified and monitored for fatigue CUF, including environmental effects. Both plant-specific OpE at NMP-1 and industry experience (e.g., NRC Bulletin 79-13) indicates that several fatigue-sensitive components (e.g., heater penetrations in the pressurizer lower head) or ASME non-Class 1 components (e.g., SG feedwater nozzles) that have high fatigue concerns may not be included in the licensee’s environmental fatigue analyses.

(c) The NMP-1 OpE essentially indicates that for plants designed before 1970, the critical plant transients considered in the fatigue design basis analyses may not be adequate. Either several transients were not being tracked or there were discrepancies in the plant event log that prevented transients from properly being identified and tracked. In addition, based on plant-specific OpE, NMP-1 added safety relief valve (SRV) discharge events to the list of monitored transients to address concerns about torus attached piping fatigue.

(d) Most BWRs have implemented HWC, and some plants have also implemented NMCA to maintain low corrosion potentials in the reactor coolant environment. However, most of the license renewal applicants do not provide any details regarding how environmental fatigue

life correction factors, F_{en}s, were calculated for the period of reactor operation, particularly during the transition periods or prior to the implementation of HWC or NMCA.

(e) With continued operation up to 80 years, the environmentally adjusted fatigue CUF is likely to exceed the allowable design limit for several components, and licensees are likely to opt for the 10 CFR 54.21(c)(1)(iii) aging management option and propose an inspection program to manage fatigue damage. However, Program Elements 4, "Detection of Aging Effects," and 7, "Corrective Actions," do not provide any guidance as to what is considered as an acceptable program.

(f) Regarding the acceptance criteria for high-energy line break (HELB) locations, it is not clear whether the selection of such locations, for environmentally assisted fatigue evaluations, is based on an allowable CUF of 0.1.

4.2.39.4 Recommendations for Subsequent License Renewal

4.2.39.4.1 Good Practices or Strengths of TLAA X.M1

M39.S-1: *Recommendation*: The criteria defined in the licensee's PBDs for selecting the critical fatigue locations monitored and tracked by the Fatigue Monitoring Program are considered a good practice or strength of the AMP.
***Technical Basis*:** Section 4.3.2.1.3 of the SRP-LR states that an acceptable method for addressing the effects of reactor coolant environment on component fatigue life is to assess the impact of the reactor coolant environment on a sample set of critical locations, which includes, as a minimum, the locations evaluated in NUREG/CR-6260. The applicant should consider adding additional locations that are considered to be more limiting than those considered in NUREG/CR-6260. However, the SRP-LR does not provide any guidance for selecting these additional locations. NMP-1 has defined the following criteria for selecting the critical fatigue locations:

1. High-fatigue usage (i.e., 40-year CUF ≥0.4);
2. Field experience suggests a fatigue concern; and
3. Important to accident scenarios (e.g., core spray nozzle).

4.2.39.4.2 Areas of TLAA X.M1 for Further Consideration/Enhancement

<u>Program Description</u>:

M39.0-1: *Recommendation*: Revise the program description to include acceptable criteria for selecting any additional fatigue sensitive locations for which the effects of the coolant environment are incorporated in the fatigue CUF analyses, and include these locations in the Fatigue Monitoring Program.
***Technical Basis*:** SRP-LR Section 4.3.2.1.3 states that the sample set of critical locations for which the effects of the reactor coolant environment on component fatigue life need to be addressed should include, as a minimum, the locations evaluated in NUREG/CR-6260. The applicant should consider adding additional locations that are considered to be more limiting than those considered in NUREG/CR-6260. However, the SRP-LR does not provide any guidance for selecting these additional locations. To help improve consistency in implementation of the Fatigue Monitoring Program, it would be helpful to include some guidance for selecting additional fatigue-sensitive locations.

M39.0-2: *Recommendation*: Revise the program description to mention clearly that this AMP not only monitors TLAAs associated with metal fatigue of the RCPB, but that it should also monitor other TLAAs, especially any component that has a CUF calculation.
***Technical Basis*:** GALL Report, Rev. 1, AMP X.M1 implicitly indicates that the program scope is limited to the RCPB components, as indicated in its title, "X.M1 Metal Fatigue of Reactor Coolant Pressure Boundary." By contrast, the scope of the program section of GALL Report, Rev. 2, AMP X.M1, states that the scope includes those components that have been identified to have a fatigue TLAA. This scope may therefore include components other than RCPB components. To help improve consistency in implementation of the Fatigue Monitoring Program, it would be helpful to include this clarification in the program description.

M39.0-3: *Recommendation*: Since Revisions 0 and 1 of the SRP-LR report did not include any expressions for calculating an environmental fatigue life correction factor, F_{en}, for nickel alloy materials, revise the program description to provide guidance on how licensees should apply the recommendations of new revisions of the SRP-LR to existing components that were reviewed under previous revisions of SRP-LR.
***Technical Basis*:** The expressions for calculating F_{en} in earlier revisions of the SRP-LR were presented in NUREG/CR-6583 for carbon and low-alloy steels and NUREG/CR-5704 for austenitic SSs, but did not include F_{en} expressions for nickel alloy materials. It would be helpful to provide guidance for applying the recommendations of new revisions of the SRP-LR to components that were reviewed under previous revisions of the SRP-LR.

M39.0-4: *Recommendation*: Revise the program description to include acceptable criteria for selecting fatigue-sensitive locations.
***Technical Basis*:** As discussed earlier in items M39.S-1 and M39.0-1, one of the criteria used at NMP-1 for identifying critical locations for fatigue CUF monitoring is fatigue CUF greater than 0.4. However, F_{en} values for SSs in HWC are typically greater than 3, and after including environmental effects the CUF would exceed the design limit. Therefore, a criterion based on a CUF of 0.4 is non-conservative, unless the validity of this threshold can be demonstrated. In addition, such a criterion should not be used to identify fatigue-sensitive locations in reactor core internal components because the effect of neutron irradiation on fatigue crack initiation is not well known.

1. <u>Scope of Program</u>:

M39.1-1: *Recommendation*: Revise the scope of the program to include some guidance for all licensees who have referenced any of the BWRVIP documents in their AMPs to address the AAIs associated with these documents that involve fatigue TLAAs.
***Technical Basis*:** Several AAIs listed in the SERs for the various BWRVIP documents referenced in the AMPs applicable to BWRs involve fatigue TLAAs. In addition, AAI #4 for BWRVIP-74-A requests that the applicant verify that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, a LR applicant must address environmental fatigue for nozzles, penetrations, and safe-ends. To ensure consistency in AMP implementation, it would be prudent to include some guidance for all licensees who have referenced any of these BWRVIP documents in their AMPs, to address the AAIs that involve fatigue TLAAs. Note that irrespective of whether these TLAAs were in the licensee's CLB, or do not meet Criterion #6 of 10 CFR 54.3, the licensee should include these six TLAAs in their licensing basis, unless the licensee has received NRC approval for deviation from the BWRVIP guidance.

M39.1-2: *Recommendation*: Revise the scope of the program to include any additional fatigue-sensitive locations for monitoring fatigue CUF TLAAs.
***Technical Basis*:** Ginna's PBDs indicated that the heater penetration in the pressurizer bottom head is a fatigue-critical component, but it was not included in the licensee's environmental fatigue analysis. In addition, industry experience (e.g., NRC Bulletin 79-13) has shown that SG feedwater nozzles have experienced fatigue cracking and, therefore, Class 1 fatigue analyses have been performed for these Class 2 components. It is recommended that OpE review (with fatigue evaluation) be performed to further identify ASME non-Class 1 components that potentially need to be included in the Fatigue Monitoring Program. Furthermore, future plant visits may be used for collecting data on fatigue sensitive locations with high CUF values or fatigue concerns, and if deemed necessary, revise the scope of the program to include additional locations that need to be included in the Fatigue Monitoring Program.

2. <u>Preventive Action</u>:

No further review items were identified.

3. <u>Parameters Monitored/Inspected</u>:

M39.3-1: *Recommendation*: Revise the parameters monitored/inspected program elements to include additional guidance to verify the adequacy of design basis transients that are tracked by the Fatigue Monitoring Program, and to evaluate the efficacy of the implementation of the monitoring program.
***Technical Basis*:** NMP-1 OpE essentially indicates that for older plants (i.e., designed before 1970) the list of critical plant transients considered in the fatigue design basis analyses may not be adequate. For example, the NMP-1 program was not tracking several transients that affected the reactor pressure vessel recirculation inlet and outlet nozzles because these transients only affected the recirculation inlet and outlet nozzles while the FW nozzles were selected as the bounding nozzles, based on the fatigue design analyses of the reactor pressure vessel. Furthermore, there were plant events important to fatigue listed in the plant event logs that were not being tracked. For example, 7 of the 14 plant events for NMP-1 were not tracked prior to 2000.

M39.3-2: *Recommendation*: The parameters monitored/inspected program elements may be revised to advise BWR licensees to include SRV discharge events (including test events) in the Fatigue Monitoring Program due to its importance in containment CUF calculations.
***Technical Basis*:** Based on plant-specific OpE, NMP-1 added SRV discharge events to the list of monitored transients to address concerns about torus attached piping fatigue. This transient is particularly important for all BWRs with a Mark I containment design, and could induce significant fatigue damage in SSCs affected by the transient.

4. <u>Detection of Aging Effects</u>:

M39.4-1: *Recommendation*: Revise the detection of aging effects program element to include a statement ensuring that all fatigue-sensitive locations are included and monitored by the Fatigue Monitoring Program.
***Technical Basis*:** The following sentences that were included in the description of this program element in GALL, Rev. 1, have been removed from Rev. 2: "The program monitors a set of sample high fatigue usage locations. This sample set includes the locations identified in NUREG/CR-6260, as minimum, or proposes alternatives based on plant configuration." To ensure timely detection of aging degradation due to fatigue damage, it is important to make sure

that all critical fatigue-sensitive locations have been identified and included in the monitoring program. A statement, similar to the one that was deleted from GALL, Rev. 2 ensuring that all critical locations should be included in the Fatigue Monitoring Program, should be added in the description of this element.

M39.4-2: *Recommendation*: Revise the detection of aging effects program element to request license renewal applicants to include a short description of the methodology for calculating F_{en} under varying water chemistry conditions.
***Technical Basis*:** During the 40-year operating period, most BWRs have implemented HWC, and some plants have also implemented NMCA, to maintain low corrosion potentials in the reactor coolant environment and mitigate SCC. For nearly all materials, the environmental fatigue life correction factor, F_{en}, is strongly dependent on the corrosion potential of the coolant environment. However, most licensees do not provide any details regarding how the plant-specific F_{en} values were calculated for the entire period of reactor operation, particularly during the transition period when HWC or NMCA were implemented. A short description of the methodology for calculating F_{en} in such situations would be very helpful for the AMR process.

M39.4-3: *Recommendation*: Revise the detection of the aging effects program element to include additional guidance for licensees who decide to use the 10 CFR 54.21(c)(1) (iii) aging management option, and propose an inspection program for managing the aging effects of fatigue.
***Technical Basis*:** Typically, the fatigue CUF of some PWR components projected to 60 years of operation and including environmental effects, exceeds the allowable design limit of 1.0. Most licensees disposition the associated TLAAs using the 10 CFR 54.21(c)(1) (iii) option, and propose an inspection program for managing the aging effects of fatigue. However, a CUF greater than 1.0 implies that the probability of fatigue crack initiation is high and the inspection program has to manage the consequence of fatigue damage (i.e., the existence and growth of a fatigue crack). Therefore, to ensure that the intended function of the component will be maintained during the period of extended operation, a program to manage the effects of fatigue should include the following items:

(a) The component and location of maximum fatigue usage should be clearly identified.

(b) The ability to access the location for inspection should be identified and reliable inspection techniques identified to detect potential fatigue cracks.

(c) To avoid uncontrolled crack extension and to establish and validate the adequacy of the inspection frequency, a flaw tolerance and growth evaluation should be performed for each location to demonstrate a postulated crack remains below the critical size until the next .inspection

5. <u>Monitoring and Trending</u>:

No further review items were identified.

6. <u>Acceptance Criteria</u>:

M39.4-1: *Recommendation*: Revise acceptance criteria program element to include guidance for HELB locations.
***Technical Basis*:** There is some confusion regarding the acceptance criteria for HELB locations, including environmental effects. It is not clear whether the selection of HELB locations for environmentally assisted fatigue evaluations is based on an allowable CUF of 0.1.

It would be prudent to update this program element to include some guidance on the acceptance criteria for HELB locations.

7. <u>Corrective Actions</u>:

M39.4-1: *Recommendation*: Revise the corrective action program element to include guidance for licensees that use the 54.21(c)(1)(iii) option and propose an inspection program to manage fatigue CUF TLAAs.
***Technical Basis*:** With continued operation, the fatigue CUF projected to 80-year operation and including environmental effects is likely to exceed the allowable design limit for several components, particularly PWR components. Consequently, licensees are likely to opt for the 10 CFR 54.21(c)(1) (iii) option to disposition fatigue TLAAs with high CUF values.

8. <u>Confirmation Process</u>:

No further review items were identified.

9. <u>Administrative Controls</u>:

No further review items were identified.

10. <u>Operating Experience</u>:

No significant concerns or further review items were identified.

4.3 AMPs for Structures

4.3.1 ASME Section XI, Subsection IWE (XI.S1)

4.3.1.1 Objective and Scope of Rev. 2 AMP XI.S1

The objective of this program is to provide AMAs for managing the aging effects for steel containments (Class MC) and steel liners for concrete containments (Class CC). The full scope of the program includes steel containment shells and their integral attachments, steel liners for concrete containments and their integral attachments, containment hatches and airlocks and moisture barriers, and pressure-retaining bolting.

To ensure the aging effects will be managed such that the intended functions of the steel containments and steel liners for concrete containments will be maintained in the PEO, the AMP relies on the following AMAs:

(1) Performing visual examination (general visual, VT-3, VT-1) ISI of the steel containments, steel liners of concrete containments, and other containment components for license renewal in accordance with 2004 ASME Code Section XI, Subsection IWE as approved in 10 CFR 50.55a. IWE specifies acceptance criteria, corrective actions, and expansion of the inspection scope when degradation exceeding the acceptance criteria is found. ASME Code Section XI, Subsection IWE requires examination of coatings that are intended to prevent corrosion.

(2) Incorporating AMAs, recommended in the Final Interim Staff Guidance LR-ISG-2006-01, for managing the potential of loss of material due to corrosion in the inaccessible areas of the BWR Mark I steel containment.

(3) Performing surface examination for detection of cracking described in NRC IN 92-20 and to address the recommendations delineated in NUREG-1339 and industry recommendations delineated in EPRI NP-5769, NP-5067, and TR-104213 for structural bolting.

(4) Performing surface examination of DMWs of vent line bellows in accordance with examination Category E-F of the ASME Code, Section XI, Subsection IWE. If surface examination is not possible, appropriate 10 CFR Part 50, Appendix J, tests may be conducted for pressure boundary components.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME code Section XI, Subsection IWE as approved in 10 CFR 50.55a;
(ii) LR-ISG-2006-01; and
(iii) NUREG-1339, EPRI NP-5769, NP-5067, and TR-104213.

4.3.1.2 Observations from Ginna and NMP-1

Ginna implements GALL Report AMP XI.S1 (ASME Section XI, Subsection IWE), combined with AMP XI.S2 (ASME Section XI, Subsection IWL) and AMP XI.S4 (10 CFR 50 Appendix J), through its existing AMP B2.1.3, “ASME Section XI, Subsections IWE & IWL Inservice Inspection.” Further details are available in the AEA TLR, ML13122A009.

The Ginna LRA indicates the following plant-specific experience:

- Loss of pre-stress in most containment tendons requiring re-tensioning of 137 tendons
- Containment moisture barrier found to be out of conformance with design drawing; loose insulation; non-conformance corrected by recaulking
- Minor corrosion of steel containment liner; wall thickness verified by UT; restoration of protective paint coating
- Low grease levels in certain tendon grease cans at top of containment; cans refilled
- Corroded and leaking tendon fill-port piping; all fill ports repaired

The Ginna containment is unique compared to a regular prestressed concrete containment. The vertical tendons are anchored at the base to rock anchors by bellows. In addition, there are neoprene pads embedded in the concrete at the base and spring line of the containment. This unique design required some additional surveillance requirements for the prestressing tendons and containment pressure tests. Further details are available in ML13122A009.

NMP-1 has a Mark-I steel containment. NMP-1 implements GALL AMP XI. S1 through its AMP B2.1.23, "ASME Section XI Inservice Inspection (Subsection IWE) Program." Further details are available in ML13122A009. The drywell sand cushion area was inspected in 1995 and 2007 using a borescope. The drains were found to be open with no trace of water or corrosion. There is no plan for additional borescope examination during PEO. However, the openings in the drain lines in the torus room are inspected during every outage.

Major observations from the NMP-1 audit include:

1. The torus is uncoated, and its thickness has reduced in isolated local pits to less than 10 mils more than minimum design thickness. NMP-1 has recognized that coating the torus is a contingency that may be needed if and when the plant applies for license renewal beyond 60 years. At the current corrosion rate, which is recalculated after every RFO following the requisite torus inspections, the minimum design thickness will not be reached at those worse case locations by the time the plant life reaches 60 years.

NMP-1 monitors torus thickness of the underwater surface by external UT of the pre-selected areas, and measuring corrosion rate of coupons installed in the torus. It was noted that this procedure may miss the detection of localized corrosion such as pitting.

4.3.1.3 Effectiveness of AMP XI.S1 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.40, "AMP Worksheet XI.S1 ASME Section XI, Subsection IWE." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.1.4.

4.3.1.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) One of the main objectives of this AMP is aging management of the torus shell of Mark I steel containment, which has severe corrosion problems. The torus interior could be uncoated and becomes a potential moisture corrosive environment. It is important to point out the corrosive environment inside the torus shell and elaborate on torus aging management in the program description.

(b) The program description states that the AMP is based on the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF.

The *Federal Register* (Vol. 76, No. 119, June 21, 2011) states the following:

> The NRC has evaluated Subsections IWB, IWC, IWD, IWE, IWF, and IWL of Section XI of the ASME B&PV Code, 2004 Edition, with the 2005 and 2006 Addenda through the 2007 Edition with the 2008 Addenda as part of the § 50.55a amendment process to determine if the conclusions of the GALL Report also apply to AMPs that rely upon the ASME B&PV Code editions and addenda that are incorporated by reference into § 50.55a by this rule. The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.

Based on the *Federal Register*, the program description should be updated to use the 2007 ASME Code Edition, inclusive of the 2008 Addenda of Section XI in the AMP.

(c) The program description states that the program is augmented to require surface examination of DMWs of vent line bellows in accordance with examination Category E-F, as specified in the 1992 Edition of the ASME Code, Section XI, Subsection IWE.

The 2007 edition of ASME code is acceptable to be adopted in AMPs for license renewal as stated in the *Federal Register* (Vol. 76, No. 119, June 21, 2011). The 1992 Edition of the ASME code may be outdated.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.S1. Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.1.3.2 Effectiveness and Implementation of AMP XI.S1

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) One of the main objectives of this AMP is aging management of the torus shell of Mark I steel containment, which has the potential for severe corrosion. The torus interior could be uncoated and becomes a potential moisture corrosive environment. It is important to point out the corrosive environment and elaborate torus aging management in the program description.

(b) For Mark I steel containment, NMP-1 performs cleaning of the area coolers in a maintenance procedure that could provide corrosion prevention for the dry well shell near and underneath the coolers and sand pocket region. The GALL program element could contain cleaning of the area coolers in maintenance procedures as a preventive action.

4.3.1.4 Recommendations for Subsequent License Renewal

4.3.1.4.1 Good Practices or Strengths of AMP XI.S1

S1.S-1: ***Recommendation*****:** Photograph the whole containment surface as a baseline record prior to the PEO.
Technical Basis**:** Ginna photographed the whole containment surface as a baseline record prior to the PEO in 2002–2003. This is considered a good practice and should be implemented at other plants.

4.3.1.4.2 Areas of AMP XI.S1 for Further Consideration/Enhancement

<u>Program Description</u>:

S1.0-1: ***Recommendation*****:** Provide the following description of the torus interior corrosive environment and details of aging management of the torus shell:

"The torus shell is constructed of CS and may have an uncoated interior shell. The interior of the torus is considered a potentially moisture corrosive environment. The interior of the torus could be filled with nitrogen and is about half full with demineralized water.

The exterior of the torus shell, including the support structures, base plates, anchor bolts, concrete support elements, and protective coatings, should be inspected every refueling outage for evidence of degradation.

Aging management of the torus should include scheduled condition monitoring to periodically assess the thickness of the shell. Condition monitoring activities consist of UT thickness measurements at pre-selected, known-minimum-thickness areas of the shell. These measurements are repeated at the same locations on a regular basis. UT thickness measurements are also performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell such as pitting corrosion. Material coupons representative of the torus shell material and inserted inside the torus are used to determine the corrosion rate, in addition to the actual measurements. The data is collected and compared to minimum wall thickness requirements. A conservative corrosion rate is developed and used to project the wall thickness at end of the period of extended operation."
Technical Basis**:** One of the main objectives of this AMP is aging management of the torus shell of Mark I steel containment, which has severe corrosion problems. The torus interior could be uncoated and becomes a potential moisture corrosive environment. It is important to point out the corrosive environment and elaborate on torus aging management in the program description.

S1.0-2: *Recommendation*: Adopt 2004 edition of the ASME Code, inclusive of the 2005 and 2006 Addenda, and the 2007 edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWL, as stated in the *Federal Register* (Vol. 76, No. 119, Tuesday, June 21).
***Technical Basis*:** The program description states that the AMP is based on the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF.

Federal Register (Vol. 76, No. 119, June 21, 2011) states the following:

> The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.

Based on the *Federal Register*, the program description needs to be updated to use the 2007 ASME Code Edition, inclusive of the 2008 Addenda of Section XI in the AMP.

S1.0-3: *Recommendation*: Adopt 2007 edition of ASME code for surface examination of DMWs of vent line bellows.
***Technical Basis*:** The program description states that the program is augmented to require surface examination of DMWs of vent line bellows in accordance with examination Category E-F, as specified in the 1992 edition of the ASME Code, Section XI, Subsection IWE.

The 2007 edition of ASME code is acceptable to be adopted in AMPs for license renewal.

1. <u>Scope of Program</u>:

S1.1-1: *Recommendation*: Update and expand the scope of program based on NRC IN 2010-12, IN 2011-15, and LR-ISG-2006-01, as appropriate.
***Technical Basis*:** There are two NRC INs issued after GALL, Rev. 2, related to corrosion of the containment liner. The information in these two NRC INs needs to be incorporated in the program element as appropriate.

2. <u>Preventive Action</u>:

S1.2-1: *Recommendation*: Include cleaning of the area coolers in maintenance procedures as a preventive action to prevent corrosion for the dry well shell near and underneath the coolers and sand pocket region.
***Technical Basis*:** For Mark I steel containment, NMP-1 performs cleaning of the area coolers in maintenance procedures, which could provide corrosion prevention for the dry well shell near and underneath the coolers and sand pocket region. The GALL program element could contain cleaning of the area coolers in maintenance procedures as a preventive action.

S1.2-2: *Recommendation*: Add coating of the inside of the torus shell as a preventive measure.
***Technical Basis*:** The torus shell of NMP-1 is not coated and little margin is left on the wall thickness (NMP-1 preliminary AEA report). Coating would reduce further degradation of the torus walls.

3. <u>Parameters Monitored/Inspected</u>:

S1.3-1: *Recommendation*: The GALL program element states, “Painted or coated surfaces are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress.” The statement should be revised as follows: “Painted or coated surfaces (including paints inside the torus shell) are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress.”
***Technical Basis*:** It is unclear whether examination of coating surfaces includes coatings inside the torus shell. Note that that torus internals can be examined during plant outage.

S1.3-2: *Recommendation*: Add parameters monitored/inspected for the torus shell, including shell thickness, internal and external shell coatings, support structure coatings, and torus support structure elements (i.e., tie rods, anchor bolts, base plates, welds).
***Technical Basis*:** The GALL program element does not provide guidance on parameters monitored/inspected for the torus shell.

NMP-1 specifies that for the torus shell, parameters monitored and inspected include the following:

(1) Shell thickness,

(2) Degraded external shell coatings and support structure coatings, and

(3) Degraded torus support structure elements (i.e., tie rods, anchor bolts, base plates, welds)

These parameters can be included in the GALL Report.

4. <u>Detection of Aging Effects</u>:

S1.4-1: *Recommendation*: Taking photographs of all of the containment surfaces as a baseline before entering the PEO would help identify aging effects in later inspections. This is a good practice and should be recommended in the program element.
***Technical Basis*:** The whole containment surface was photographed in NMP-1 as a baseline before entering the PEO. This is a good practice and should be implemented as a generic good practice for all plants.

S1.4-1: *Recommendation*: Add inspection of the inside of the torus during outages and focus on the areas close to the water-air interface line.
***Technical Basis*:** The torus shell of NMP-1 is not coated and little margin is left on the wall thickness based on the NMP-1 audit report. The shell wall is more susceptible to corrosion close to the water-air interface line inside the torus shell.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

S1.6-1: *Recommendation*: Incorporate the acceptance criteria used in NMP-1 as guidance for Mark I steel containment.

***Technical Basis*:** The GALL Review does not provide guidance on acceptance criteria of Mark I steel containment. The acceptance criteria of NMP-1 steel containment consist of the following elements:

(1) For Mark I steel containment, the projected wall thickness at the end of PEO should be greater than the minimum design wall thickness. The wall thickness and corrosion rate (mils/year) should be periodically measured in accordance with IWE requirements.

(2) Torus shell thickness should not be less than the required thickness through the PEO.

(3) Acceptance criteria of local wall thickness and average wall thickness, and conservative corrosion rates should be established. The minimum wall thickness and corrosion rate limits should be defined to ensure that the minimum wall thickness requirement will not be violated before the next scheduled inspection. Incorporate the acceptance criteria used in NMP-1 as guidance for Mark I steel containment in the GALL Report.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S1.10-1: *Recommendation*: Include OpE described in the following:
(1) NRC IN 97-10.
(2) NRC IN 2010-12, "Containment Liner Corrosion."
(3) NRC IN 2011-15, "Steel Containment Degradation and Associated License Renewal Aging Management Issues."

***Technical Basis*:** NRC issued IN 2011-15, "Steel Containment Degradation and Associated License Renewal Aging Management Issues," on the recent issues identified concerning degradation of steel containment that could impact aging management of containment structures during the PEO. The IN describes the problems found in recent inspections of steel containments in the Cooper, Hope Creek, and Dresden plants. NRC issued IN 2010-12, "Containment Liner Corrosion," addressing corrosion of steel containment liners of the Beaver Valley, Salem, and Brunswick plants. NRC IN 97-10 addresses liner plate corrosion at the Robinson Nuclear Plant (RNP). The OpE mentioned in these NRC INs is not included in the GALL Report.

S1.10-2: *Recommendation*: The following should be stated: "GL 87-05 addressed the potential for corrosion and needs for inspection of BWR Mark I steel drywells in the "sand pocket region.""

***Technical Basis*:** The GALL program element states the following: "GL 87-05 addressed the potential for corrosion of BWR Mark I steel drywells in the "sand pocket region." GL 87-05 also addresses the inspection of BWR Mark I steel drywells in the "sand pocket region."

S1.10-3: *Recommendation*: The following should be stated: “These condensation oscillations induced on the torus shell may have been excessive due to a lack of a high-pressure cooling injection (HPCI) turbine exhaust pipe sparger that many licensees have installed. Dry well liner also experienced major rust under area coolers.”
***Technical Basis*:** The GALL program element states the following: “These condensation oscillations induced on the torus shell may have been excessive due to a lack of an HPCI turbine exhaust pipe sparger that many licensees have installed.” This OpE is from James A. Fitzpatrick NPP. OpE of NMP-1 also indicates that dry well liner also experienced major rust under area coolers.

S1.10-4: *Recommendation*: The following should be stated: “Other OpE indicates that foreign objects embedded in concrete have caused through-wall corrosion of the liner plate at a few plants with reinforced concrete containments. Through-wall cracking was detected in the torus. The crack was repaired by welding a plate on the outside of the shell.”
***Technical Basis*:** The GALL program element states the following: “Other OpE indicates that foreign objects embedded in concrete have caused through-wall corrosion of the liner plate at a few plants with reinforced concrete containments. NMP-1 OpE indicates that through-wall cracking was detected in the torus and the crack was repaired by welding a plate on outside of the shell.”

4.3.2 ASME Section XI, Subsection IWL (XI.S2)

4.3.2.1 Objective and Scope of Rev. 2 AMP XI.S2

The objective of this program is to provide AMAs for effectively managing the aging effects for reinforced and prestressed concrete containments. To ensure the aging effects will be managed such that the intended functions of the containment reinforced concrete and unbonded post-tensioning systems will be maintained in the PEO, the AMP relies on the following AMA:

(1) ISI of the containment reinforced concrete and unbonded post-tensioning systems in accordance with 2004 ASME code Section XI, Subsection IWF as approved in 10 CFR 50.55a. Tendon anchorages and wires are visually examined. Tendon wires are tested for verification that minimum mechanical properties requirements are met. Tendon corrosion protection medium is analyzed for alkalinity content and soluble ion concentrations. Prestressing forces are measured in selected sample tendons.

Thus, the AMP relies on the requirements or guidance from the following document:
ASME code Section XI, Subsection IWL as approved in 10 CFR 50.55a.

4.3.2.2 Observations from Ginna and NMP-1

Ginna has a prestressed concrete containment. As stated in Section 2.4.1, Ginna combines this program with GALL XI.S1 (ASME Section XI, Subsection IWE) and AMP XI.S4 (10 CFR 50, Appendix J) through its AMP B2.1.3, “ASME Section XI, Subsections IWE & IWL Inservice Inspection.” In addition, Ginna has a separate TLAA AMP B3.3, “Concrete Containment Tendon Prestress,” for managing loss of tendon prestressing. Ginna’s IWE/IWL AMP also manages 10 CFR Part 50, Appendix J, containment leak rate tests. NMP-1 has a Mark I steel containment, and thus this program is not applicable.

Ginna’s IWE & IWL program consists of (a) periodic visual inspections of concrete surfaces for the prestressed concrete containment, (b) periodic visual inspections and sample tendon testing of unbonded post-tensioning systems for evidence of degradation, and (c) assessment of damage and corrective actions. Measured tendon lift-off forces are compared to the predicted tendon forces calculated in accordance with RG 1.35.

The evaluations of Ginna’s IWL/IWE program regarding the prestressed containment and prestressing tendon systems are described in Sections 2.4.1 and 2.4.9 of ML13122A009. Observations in Ginna’s IWE AMP, described in Section 2.4.1, also apply here, including:

- The AMP basis document has not been updated.

The program is currently being implemented in accordance with ASME 2004 code in accordance with 10 CFR 50.55a; however, the basis document referenced the 1995 edition of the code.

4.3.2.3 Effectiveness of AMP XI.S2 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices

or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.41, "AMP Worksheet XI.S2 ASME Section XI, Subsection IWL." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.2.4.

4.3.2.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) At Ginna, hot penetrations in containments were designed with a forced air cooling system connected to cooling coils integrated with the penetration sleeves. The cooling air exit temperature is monitored and can be related to the concrete-to-sleeve interface temperature. The Penetration Cooling System is within the scope of license renewal and is included in the AMR for the Essential Ventilation System.

The primary shield wall concrete is also subject to extended local heatup at Ginna Station. The purpose of the reactor compartment cooling system is to remove the heat generated by gamma radiation in the primary shield and the thermal radiation from the reactor vessel and out-of-core detectors electrical load. Removal of this heat maintains the concrete temperature in the primary shield walls below degradation threshold and localized temperature limits of ACI standards (i.e., 150°F). The reactor compartment cooling system is also within the scope of license renewal and is included in the AMR for the Containment Ventilation system.

The GALL Report does not include aging management of the containment cooling systems that controls concrete temperatures. The program description may need to be expanded including aging management of the containment cooling systems.

(b) The program description states that the AMP is based on the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF.

The *Federal Register* (Vol. 76, No. 119, June 21, 2011) states the following:

> The NRC has evaluated Subsections IWB, IWC, IWD, IWE, IWF, and IWL of Section XI of the ASME B&PV Code, 2004 Edition with the 2005 and 2006 Addenda through the 2007 Edition with the 2008 Addenda as part of the § 50.55a amendment process to determine if the conclusions of the GALL Report also apply to AMPs that rely upon the ASME B&PV Code editions and addenda that are incorporated by reference into § 50.55a by this rule. The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.

Based on the *Federal Register*, the program description should be updated to use the 2007 ASME Code Edition, inclusive of the 2008 Addenda of Section XI in the AMP.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with GALL, Rev. 0, AMP XI.S2.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.2.3.2 Effectiveness and Implementation of AMP XI.S2

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Recent plant OpE indicates several cases of groundwater penetration/leakage:

1. Reactor cavity water leakage 3–10 gallons/minute or 4,000–10,000 gallons/day since 1999. (Staff audit report on Ginna Structures Monitoring AMP).

2. An NRC 2011 inspection report revealed that groundwater penetration to an underground electric tunnel at Seabrook caused concrete to lose more than 20% of its strength. The degradation is due to sulfate attack when concrete is saturated in water.

3. NMP-1 OpE (SER 3.0.3.2.21):

   - Minor cracking is present in various concrete structures, as are slight (but stable) groundwater leaks in some tunnels;

   - Several CRs have identified minor cracking in concrete structures including the service water pipe tunnel, which is susceptible to small wall cracks allowing leakage of groundwater.

   - Groundwater has also entered the switchgear building, service water tunnels, and radwaste building through below-grade exterior walls.

This OpE indicates that the XI.S2 ASME Section XI, Subsection IWL may not be effective in dealing with the groundwater leakage problems and associated aging effects.

4.3.2.4 Recommendations for Subsequent License Renewal

4.3.2.4.1 Good Practices or Strengths of AMP XI.S2

S2.S-1: *Recommendation*: Photograph the whole containment surface as a baseline record prior to the PEO.

***Technical Basis*:** Ginna photographed the whole containment surface as a baseline record prior to the PEO in 2002–2003. This is considered a good practice and should be implemented at other plants.

4.3.2.4.2 Areas of AMP XI.S2 for Further Consideration/Enhancement

Program Description:

S2.0-1: *Recommendation*: Include aging management of concrete cooling systems in the program description.
***Technical Basis*:** At Ginna, hot penetrations in containments were designed with a forced air cooling system connected to cooling coils integrated with the penetration sleeves. The cooling air exit temperature is monitored and can be related to the concrete-to-sleeve interface temperature. The Penetration Cooling System is within the scope of license renewal and is included in the AMR for the essential ventilation system.

The primary shield wall concrete is also subject to extended local heatup at Ginna Station. The purpose of the reactor compartment cooling system is to remove the heat generated by gamma radiation in the primary shield and the thermal radiation from the reactor vessel and out-of-core detectors electrical load. Removal of this heat maintains the concrete temperature in the primary shield walls below degradation threshold and localized temperature limits of ACI standards (i.e., 150°F). The reactor compartment cooling system is also within the scope of license renewal and is included in the AMR for the containment ventilation system.

S2.0-2: *Recommendation*: Address aging management in dealing with groundwater penetration/leakage in the program description. Aging management of structures due to groundwater penetration/leakage could be an important task in the program.
***Technical Basis*:** Groundwater penetration/leakage occurs frequently in the plants. It could become a severe problem as plants age. Examples of recent OpE of groundwater penetration/leakage include the following:

1. Reactor cavity water leakage 3–10 gallons/minute or 4,000–10,000 gallons/day since 1999. (Staff audit report on Ginna Structures Monitoring AMP).

2. An NRC 2011 inspection report revealed that groundwater penetration to an underground electric tunnel at Seabrook plant caused concrete to lose more than 20% of its strength. The degradation is due to sulfate attack when the concrete is saturated in water.

3. NMP-1 OpE (SER 3.0.3.2.21):

   - Minor cracking is present in various concrete structures, as are slight (but stable) groundwater leaks in some tunnels.

   - Several CRs have identified minor cracking in concrete structures including the service water pipe tunnel, which is susceptible to small wall cracks allowing leakage of groundwater.

   - Groundwater has also entered the switchgear building, service water tunnels, and the radwaste building through below-grade exterior walls.

This OpE indicates that the AMP may need to be enhanced in dealing with groundwater penetration/leakage.

S2.0-3: *Recommendation*: Adopt the AMP of 2004 edition, inclusive of the 2005 and 2006 Addenda, and the 2007 edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWL, as stated in the *Federal Register* (Vol. 76, No. 119, Tuesday, June 21).
***Technical Basis*:** The program description states that the AMP is based on the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF.

The *Federal Register* (Vol. 76, No. 119, June 21, 2011) states the following:

> The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.

Based on the *Federal Register*, the program description needs to be updated to use the 2007 ASME Code Edition, inclusive of the 2008 Addenda of Section XI in the AMP.

1. <u>Scope of Program</u>:

S2.1-1: *Recommendation*: Include concrete cooling systems that control concrete temperatures, such as the penetration cooling system and reactor compartment cooling system, in the scope of the AMP.
***Technical Basis*:** At Ginna, hot penetrations in containments were designed with a forced air cooling system connected to cooling coils integrated with the penetration sleeves. The cooling air exit temperature is monitored and is related to the concrete-to-sleeve interface temperature to maintain the concrete temperature below degradation threshold and localized temperature limits of ACI standards (i.e., 150°F). The Penetration Cooling System at Ginna is within the scope of license renewal and is included in the AMR for the essential ventilation system.

The primary shield wall concrete is also subject to extended local heatup at Ginna Station. The reactor compartment cooling system is designed to remove the heat and to maintain the concrete temperature below degradation threshold and localized temperature limits of ACI standards (i.e., 150°F). The reactor compartment cooling system is also within the scope of license renewal and is included in the AMR for the containment ventilation system.

The GALL Report needs to include aging management of the containment cooling systems that control concrete temperatures.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

S2.3-1: *Recommendation*: Photograph the whole containment surface as a baseline record prior to the PEO.
***Technical Basis*:** Ginna photographed the whole containment surface as a baseline record prior to the PEO in 2002–2003. This is considered a good practice and should be implemented at other plants.

4. <u>Detection of Aging Effects</u>:

S2.4-1: *Recommendation*: Include detection of aging effects due to DEF in the program element Detection of Aging Effects.
***Technical Basis*:** The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures. This degradation is caused by excessive heat curing that decomposes the ettringite in Portland cement during the hydration process. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, the destructive expansive forces of which crack the concrete.

5. <u>Monitoring and Trending</u>:

S2.5-1: *Recommendation:* Change the program element name from "Monitoring and Trending" to "Trending" to emphasize the importance of trending on a regular basis (e.g., providing trending report on a 6-month basis).
***Technical Basis*:** NMP-1 appears have no trending report that takes place on a regular basis. It is important to stress the importance of performing trending on a regular basis.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S2.10-1: *Recommendation*: Include OpE from recent NRC INs:

1. NRC IN 2010-14, *Containment Concrete Surface Condition Examination Frequency and Acceptance*.

2. NRC IN 99-10, *Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments*.
***Technical Basis*:** The program element does not contain information from recent NRC INs related to containment degradation.

4.3.3 ASME Section XI, Subsection IWF (XI.S3)

4.3.3.1 Objective and Scope of Rev. 2 AMP XI.S3

The objective of this program is to provide AMAs for effectively managing the aging effects in Classes 1, 2, and 3, and metal containment (MC) piping and components and their supports. To ensure the piping and component supports remain functional during the PEO, the AMP relies on the following AMAs:

(1) ISI of Classes 1, 2, and 3, and MC piping and components and their supports in accordance with 2004 ASME Code Section XI, Subsection IWF as approved in 10 CFR 50.55a.

(2) Monitoring of high-strength structural bolting (actual measured yield strength greater than or equal to 150 ksi or 1,034 MPa) for cracking.

(3) Incorporate recommendations delineated in NUREG-1339 and industry recommendations delineated in EPRI NP-5769, NP-5067, and TR-104213 for high-strength structural bolting, if applicable, for proper selection of bolting material, lubricants, and installation torque or tension to prevent or minimize loss of bolting preload and cracking of high-strength bolting.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME Code Section XI, Subsection IWF, as approved in 10 CFR 50.55a; and
(ii) NUREG-1339, EPRI NP-5769, NP-5067, and TR-104213.

4.3.3.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.4, “ASME Section XI, Subsections IWF Inservice Inspection,” and NMP-1 through its existing AMP B2.1.25, “ASME Section XI Inservice Inspection (Subsection IWF) Program.”

It was noted during the audit that a license renewal commitment regarding volumetric (UT) examination of the high-strength bolts in the SER was eliminated by a 10 CFR 50.59 evaluation. The licensee indicated that the high-strength bolts were replaced due to potential or actual SCC, and the licensee has used a 10 CFR 50.59 approach to eliminate the commitment to perform UT examination of the high-strength bolts. The basis for this change was based on ASME Subsection IWF and plant-specific operating experience. The PBD, LR-IWF-PROGPLAN, cites the operating experience for high-strength bolt failures and their removal. The 56 bolts were tightened using a standard stud wrench, which eliminated the excessively high preload. Inspections during subsequent outages revealed no evidence of bolt distress. The licensee cleaned and painted all component anchor bolts located in the sub-basement to inhibit corrosion.

The NMP-1 IWF Program is an existing program that manages aging of carbon steel component and piping supports, including ASME Class MC supports, due to general corrosion and wear. It was noted that the NMP-1 IWF AMP does not include inaccessible piping supports. This may be attributed to the fact that the GALL Report IWF AMP only recommends inspection of piping and components supports that are not exempt from ASME IWF-1230 and MC supports.

Other observations from the audit of NMP-1’s IWF AMP include that the most recent quarterly Health Reports of the ISI Program (July–September 2011) rates the program as ACCEPTABLE and GREEN.

Further details of these programs are available in the AEA TLR, ML13122A009.

4.3.3.3 Effectiveness of AMP XI.S3 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.42, "AMP Worksheet XI.S3 ASME Section XI, Subsection IWF." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.3.4.

4.3.3.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) GALL, Rev. 2, is augmented to include monitoring of high-strength structural bolting based on NUREG-1339 and industry recommendations. For AMPs developed based on GALL, Rev. 0, such as that of Ginna, monitoring high-strength bolting is not included. Therefore, the program description may need to add the following statement to reflect the need of monitoring of high-strength structural bolting:

"For IWF AMPs developed based on previous GALL versions, the licensee may require AMP updates to include monitoring of the high-strength bolting."

(b) The program description states that the AMP is based on the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF.

The *Federal Register* (Vol. 76, No. 119, June 21, 2011) states the following:

> The NRC has evaluated Subsections IWB, IWC, IWD, IWE, IWF, and IWL of Section XI of the ASME B&PV Code, 2004 Edition with the 2005 and 2006 Addenda through the 2007 Edition with the 2008 Addenda as part of the § 50.55a amendment process to determine if the conclusions of the GALL Report also apply to AMPs that rely upon the ASME B&PV Code editions and addenda that are incorporated by reference into § 50.55a by this rule. The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.

Based on the *Federal Register*, the program description should be updated to use the 2007 ASME Code Edition, inclusive of the 2008 Addenda of Section XI in the AMP.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.S3.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.3.3.2 Effectiveness and Implementation of AMP XI.S3

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) GALL, Rev. 2, is augmented to include monitoring of high-strength structural bolting based on NUREG-1339 and industry recommendations. Ginna's IWF AMP is based on GALL, Rev. 0, and monitoring of high-strength bolting is not included in the PBD. The licensee should update PBDs to reflect changes in the latest version of the GALL Report. (This could be a generic implementation issue that AMPs developed based on previous GALL versions may not contain the augmentations in the latest version of the GALL Report [i.e., GALL, Rev. 2].)

4.3.3.4 Recommendations for Subsequent License Renewal

4.3.3.4.1 Good Practices or Strengths of AMP XI.S3

S3.S-1: *Recommendation*: Add painting of the anchor bolts as preventive action.
***Technical Basis*:** Ginna cleaned and painted all component anchor bolts located in the sub-basement to stop corrosion. This is considered as good practice and should be used on a generic basis and recommended in the GALL AMP.

4.3.3.4.2 Areas of AMP XI.S3 for Further Consideration/Enhancement

<u>Program Description</u>:

S3.0-1: *Recommendation*: Adopt the AMP of 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsection IWF, as stated in the *Federal Register* (Vol. 76, No. 119, Tuesday, June 21).
***Technical Basis*:** The program description states that the AMP is based on the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF.

The *Federal Register* (Vol. 76, No. 119, June 21, 2011) states the following:

> The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.

Based on the *Federal Register*, the program description needs to be updated to use the 2007 ASME Code Edition, inclusive of the 2008 Addenda of Section XI in the AMP.

1. <u>Scope of Program</u>:

S3.1-1: *Recommendation*: The GALL IWF should include the inaccessible items exempted from IWB-1220 in the scope of program. These inaccessible items, according IWB-1220, include portions of supports that are inaccessible due to being encased in concrete, buried underground, or encapsulated by guard pipe.
***Technical Basis*:** 10 CFR 50.55a(b)(2)(ix) specifies additional requirements for inaccessible areas. It states that the licensee is to 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. The NWP-1 IWF AMP does not include inaccessible piping supports because the GALL IWF AMP only recommends that inspection of piping and components supports that are not exempt from IWF -1230 and MC supports. Exemptions, as stated in IWB-1220, include portions of supports that are inaccessible due to being encased in concrete, buried underground, or encapsulated by guard pipe.

The inaccessible components (e.g., embedded containment components) are included in the scope of program of the GALL XI.S2 IWE AMP, which states that the licensee is to 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.

2. <u>Preventive Action</u>:

S3.1-1: *Recommendation*: Add painting of the anchor bolts as a preventive action. The following statement could be added in the program element to reflect good practice: “Although corrosion of anchor bolts in managed by VT-3 visual inspection, cleaning and painting all support anchor bolts is considered a good practice and is recommended as a preventive action for stopping corrosion.”
***Technical Basis*:** Although corrosion of anchor bolts is managed by VT-3 visual inspection, painting the anchor bolting would prevent corrosion. Ginna cleaned and painted all component anchor bolts located in the sub-basement to stop corrosion. This is considered a good practice and should be used on a generic basis and recommended in the GALL AMP.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

S3.4-1: *Recommendation*. Revise this element description to include an assessment of the impact of EPU modifications on Class 1, 2, 3, and MC piping and component supports, particularly for the main steam line.
***Technical Basis*:** Increased loadings at equipment and piping supports due to EPU may impact this AMP requiring, for example, a larger sample size to ensure that the aging effects are detected in a timely manner.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S3.10-1: *Recommendation*: Include NRC IN 2009-04 in the OpE.
***Technical Basis*:** NRC IN 2009-04, "Age-Related Constant Support Degradation" (Feb. 18, 2009), describes deviations in the supporting forces due to wear on the linkage and increased friction between the various moving parts and joints within the constant support.

4.3.4 10 CFR 50, Appendix J (XI.S4)

4.3.4.1 Objective and Scope of Rev. 2 AMP XI.S4

The objective of Appendix J is to identify and quantify leakages in the containment structure and penetrations through containment leak rate tests to ensure the primary containment will perform its isolation safety function during the PEO. Appendix J also requires a general visual inspection of the accessible interior and exterior surfaces of the containment structure and components be performed prior to any leakage rate Type A tests in order to allow early detection of structural and component degradation.

To ensure the containment remains functional during the PEO, the AMP relies on the following AMAs:

(1) Performing either deterministic-based Option A or performance-based Option B containment leakage rate test (LRT in accordance to NRC RG 1.163 and NEI 94-01 as approved by the NRC Final Safety Evaluation for NEI Topical Report (TR) 94-01, Rev. 2.

(2) General visual inspection of the accessible interior and exterior surfaces of the containment structure and components performed prior to any Appendix J, Type A, containment leakage test in accordance with the ASME Section XI. Subsection IWL (AMP XI.S2) is an acceptable substitute for Subsection IWE.

The Appendix J leak rate test together with IWE or IWL inspection ensures containment integrity.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) NRC RG 1.163 and NEI 94-01; and
(ii) ASME Section XI, Subsection IWE and ASME Section XI, IWL.

4.3.4.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.3, “ASME Section XI Subsections IWE & IWL Inservice Inspection.” Further details are available in the AEA TLR, ML13122A009.

During the Ginna LRA review, the licensee committed to perform two structural integrity tests at design pressure during PEO in 2015 and 2026. The staff noted that the licensee has revised this commitment by using the 10 CFR 50.59 screening process to align the schedule with the integrated leak rate test (ILRT).

NMP-1 implements the GALL Report XI.S4 AMP through its existing “10 CFR 50 Appendix J Program,” which detects degradation of the containment structure and components that comprise the containment pressure boundary. Further details are available in ML13122A009.

Incidents of containment leakage that have been detected and documented in the NMP-1 basis document include:

- Leakages on the main steam penetration bellows were detected by Type B test due to cracks in the HAZ of seam welds.
- Containment interior wall leak paths were identified through Type A tests.

- Torus leakages have been reported due to fatigue in the proximity of the high-pressure coolant injection (HPCI) system line.

The NMP-1 basis document indicated that Type C test leakages (involving the containment isolation valve) are the most common leakage events, and typical corrective actions involve valve disc-to-seat maintenance to improve leak-tightness. The basis document also indicated that Type B tests are sufficiently sensitive to identify degraded components that impact component leak-tightness requiring corrective actions.

Containment leakage events have been detected and documented and corrective actions were taken.

4.3.4.3 Effectiveness of AMP XI.S4 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.43, "AMP Worksheet XI.S4 10 CFR 50, Appendix J." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.4.4.

4.3.4.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) A typical reactor containment consists of over 100 electrical and mechanical penetrations, two or three equipment hatches, and personal air locks. The containment can be subjected to various types of aging degradation, depending on the inherent characteristics of the materials, the fabrication processes, and the construction methods. One key important factor of containment aging management is that the test results of Appendix J must be compared with previous results to examine the performance history of the overall containment system to limit leakage and to track the degradation. The GALL Report needs to stress the importance of tracking the performance history of containments systems in the program description.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.S4, with exceptions and enhancements. Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.4.3.2 Effectiveness and Implementation of AMP XI.S4

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL program element only suggests monitoring of leakage rates from the containment pressure test. More parameters (e.g., loss of material due to corrosion, SCC, loss of sealing, elastomer degradation, and loss of leak lightness due to material degradation) need to be monitored because the Appendix J AMP also involves ASME IWE/IWL visual inspection.

4.3.4.4 Recommendations for Subsequent License Renewal

4.3.4.4.1 Good Practices or Strengths of AMP XI.S4

No specific good practice was identified during the review.

4.3.4.4.2 Areas of AMP XI.S4 for Further Consideration/Enhancement

Program Description:

S4.0-1: *Recommendation*: Insert the following paragraphs at beginning of the program description to point out the importance of tracking the degradation and objectives of Appendix J:

"A typical reactor containment consists of a containment structure, over 100 electrical and mechanical penetrations, two or three equipment hatches, and personal air locks. The containment can be subjected to various types of aging degradation, depending on the inherent characteristics of the materials, the fabrication processes, and the construction methods. The rate and extent of the degradation are influenced by sustained environmental conditions, such as temperature, humidity, water leakage, and borated water spills. To ensure reliability of the containment, it is necessary to track the degradation of the containment components through periodic inspections and check the leak-tight integrity of the containment's pressure-retaining components through periodic leak rate testing."

The objective of Appendix J is to identify and quantify leakage through the primary containment, as well as systems and components penetrating primary containment, to ensure containment will perform its isolation safety function. This accomplished by:

(a) Performing Type B or Type C testing of individual components.

(b) Monitoring leakage for indication of degradation.

(c) Implementing corrective actions necessary to manage the Type B and C summary total within established acceptance criteria.

(d) Periodically perform Type A tests for integrated leak rate testing (ILRT) to verify total containment structure and penetration tightness.

***Technical Basis*:** A typical reactor containment consists of over 100 electrical and mechanical penetrations, two or three equipment hatches, and personal air locks. The containment can be

subjected to various types of aging degradation, depending on the inherent characteristics of the materials, the fabrication processes, and the construction methods. One key important factor of containment aging management is that the test results of Appendix J must be compared with previous results to examine the performance history of the overall containment system to limit leakage and to track the degradation. The GALL Report needs to stress the importance of tracking the performance history of containments systems.

S4.0-2: *Recommendation*: Add additional details (underlined) to the program description.

> Appendix J provides two options, Option A (deterministic-based) and Option B (performance-based), either of which can be chosen to meet the requirements of containment leakage rate test (LRT program. Option A is prescriptive with all testing performed on specified, uniform periodic intervals. Option B is a performance-based approach. Some of the differences between these options are discussed below. More detailed information for Option B is provided in the NRC RG 1.163 and NEI 94-01 as approved by the NRC Final Safety Evaluation for the NEI TR 94-01, Rev. 2.Three types of tests are performed under either Option A or Option B.
>
> Type A tests (integrated leak rate testing; ILRT are performed to determine the overall primary containment integrated leakage rate at the loss of coolant accident peak containment pressure.
>
> Type B tests (containment penetration leak rate testing) are intended to detect local leaks and to measure leakage across each pressure-containing or leakage-limiting boundary of containment penetrations.
>
> Type C tests (containment isolation valve leak rate testing) are intended to detect local leaks and to measure leakage across containment isolation valves installed in containment penetrations or lines penetrating containment. If Type C tests are not performed under this program, they could be included under an ASME Code, Section XI, Inservice Test Program leakage testing for systems containing the isolation valves.
>
> Appendix J requires a general visual inspection of the accessible interior and exterior surfaces of the containment structure and components be performed prior to any Type A test in order to allow early detection of structural and component degradation. General Visual examinations performed in accordance with the ASME Section XI, Subsection IWE (AMP XI.S1) or ASME Section XI, Subsection IWL (AMP XI.S2) program are an acceptable substitute. The purpose of the inspection is to uncover any evidence of structural deterioration that may affect the containment structural integrity or leak-tightness. If there is evidence of structural deterioration, the Type A test is not performed until corrective action is taken in accordance with the repair/replacement procedures. The ISI, together with the Appendix J leak rate test, is to ensure containment integrity.

***Technical Basis*:** More detailed explanations of the program description are necessary, including an explanation of the objective of the ISIs.

1. <u>Scope of Program</u>:

S4.1-1: *Recommendation*: Provide a list of containment boundary pressure-retaining components in the scope of program. The list of containment boundary pressure-retaining components consists of containment structure, all penetrations, equipment hatches, personal air

locks, and containment isolation valves.
***Technical Basis*:** The program element simply states that scope of the containment LRT program includes all containment boundary pressure-retaining components. It does not mention what those containment boundary pressure-retaining components are.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

S4.3-1: *Recommendation*: Add additional parameters of the aging effects to be monitored. These include loss of material due to corrosion, SCC, loss of sealing, elastomer degradation, and loss of leak tightness due to material degradation. Note that elastomer degradation is also covered under 10 CFR 50.49 ("Environmental qualification of electric equipment important to safety for nuclear power plants").
***Technical Basis*:** The program element states that parameters to be monitored include leakage rates through containment shells, containment liners, and associated welds, penetrations, fittings, and other access openings. Because the AMP also include IWE or IWL visual inspection, aging effects such as loss of material due to corrosion, SCC, loss of sealing, elastomer degradation, and loss of leak tightness due to material degradation should also be monitored.

4. <u>Detection of Aging Effects</u>:

S4.4-1: *Recommendation*: Replace the program statement that says, "the leakage rate test does not by itself provide information that would indicate that aging degradation has initiated," with the following: "Type B tests are sensitive and able to detect degradations due to aging effects. Once degradations are detected, they should be tracked. Additional implementation of ISI programs of ASME Section XI, Subsection IWE (AMP XI.S1), and ASME Section XI, Subsection IWL (AMP XI.S2), will further assist detection of aging effects.
***Technical Basis*:** The GALL program element states that the LRT does not by itself provide information that would indicate that aging degradation has initiated. This statement may be misleading. Based on the NMP-1 PBD, in Type B tests sensitive, degraded components that impact component leak tightness are identified as requiring corrective actions.

S4.4-2: *Recommendation*: Point out that the acceptable method and techniques for performing Type A, B, and C containment leakage testing are documented in ANSI/ANS-56.8.
***Technical Basis*:** The GALL program element does not provide guidance on the acceptable methods and techniques for performing Type A, B, and C containment leakage testing. It would be helpful to point out that the acceptable methods and techniques for performing Type A, B, and C containment leakage testing are documented in ANSI/ANS-56.8. (ANSI/ANS-56.8 should also be added to the references.)

S4.4-3: *Recommendation*: Provide guidelines on frequencies of Type A, B and C tests based on RG 1.163 and NEI 94-01. Below are two examples of test frequencies that should be added to the program element.

In Option B, the periodic Type A test interval can be increased to 10 years based on performance history of the Type A tests as defined in NEI 94-01. For Penetrations, Type B tests are performed at least once every 24 months on each penetration. The test interval can be

extended to 10 years based on performance history of individual penetration. Tests of containment air locks and their components are performed once every 24 months.

For Type C tests, the maximum interval for BWR main steam and feedwater isolation valves, and PWR and BWR containment purge and vent valves is limited to 30 months. For other types of isolation valves, the maximum test interval is limited to 5 years based on RG 1.163.

***Technical Basis*:** The GALL program element has no detailed guidelines on test frequencies of Types A, B, and C tests of various components. There are some differences between RG 1.166 and NEI 94-01 regarding the test frequencies of Appendix J. The GALL program element needs to provide detailed guidelines on the test frequencies of Types A, B, and C tests on various components to ensure the aging effects can be detected in a timely manner.

S4.4-4: *Recommendation*: Add the following statement to the program element to reflect the need to take EPU modifications into consideration: "For plants with EPU modification, the effects of EPU on Appendix J testing should be taken into consideration. Plant with EPU modification may require higher test pressures in the Appendix J LRTs.
***Technical Basis*:** NMP-2 has performed EPU. During the AMP audit session of Appendix J session, NMP-1 engineers stated that the pressure of Appendix J test in NMP-2 is increased after EPU modification. The GALL Report needs to address the impact of EPU on the Appendix J testing.

S4.4-5: *Recommendation*: The inspector of Appendix J test should be qualified in accordance with ASME Section XI, IWA 3200.
***Technical Basis*:** The GALL Report does not provide guidance on qualification of inspectors. Inspectors should be qualified in accordance with ASME Section XI, IWA 3200.

5. <u>Monitoring and Trending</u>:

S4.5-1: *Recommendation:* The following statements should be added to the GALL program element: "It is necessary to track the degradation of the containment components through periodic inspections and check the leak-tight integrity of the containment's pressure-retaining components through periodic leak rate testing. Trending for the 10 CFR 50, Appendix J program is important, as stated in 10 CFR Part 50 Appendix J: "The test results must be compared with previous results to examine the performance history of the overall containment system to limit leakage.""
***Technical Basis*:** The GALL program element does not provide guidance on trending. Trending for the 10 CFR 50, Appendix J, program is important, as stated in 10 CFR Part 50 Appendix J: "The test results must be compared with previous results to examine the performance history of the overall containment system to limit leakage."

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S4.10-1: *Recommendation*: Include the containment leakage cases in the GALL program element based on NMP-1 OpE.
***Technical Basis*:** The GALL program element does not provide examples of leakage of containment pressure boundary. The NMP-1 basis document lists the following leakage cases at NMP-1: "Leakages on the main steam penetration bellows were detected by Type B test due to cracks in the HAZ of seam welds. Interior wall leak paths were identified through Type A tests. Torus leakages have been reported due to fatigue at proximity of HPCI system line. Type C tests (containment isolation valve) are the most common failure events. Typical corrective actions involve valve disc to seat maintenance to improve leak tightness."

4.3.5 Masonry Walls (XI.S5)

4.3.5.1 Objective and Scope of Rev. 2 AMP XI.S5

The objective of the program is to manage the aging effects of masonry walls so that the evaluation basis established in response to NRC IEB 80-11 for each masonry wall within the scope of license renewal remains valid through the PEO.

To ensure the masonry walls remains functional during the extended period of operation, the AMP relies on the following AMAs:

(1) The program requires periodic visual inspection of masonry walls in the scope of license renewal to detect loss of material and cracking of masonry units and mortar in accordance with NRC IEB 80-11 and NRC IN 87-67. The aging effects that could impact masonry wall intended function or potentially invalidate its evaluation basis are entered in the corrective action process for further analysis, repair, or replacement.

(2) Masonry walls may be inspected as part of the Structures Monitoring Program (AMP XI.S6) conducted for the Maintenance Rule (10 CFR 50.65), provided the 10 program element attributes of XI.S5, Masonry Walls, are incorporated in AMP XI.S6. The aging effects on masonry walls that are considered fire barriers also are managed by AMP XI.M26, Fire Protection.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) Maintenance Rule (10 CFR 50.65); and
(ii) NRC IEB 80-11 and NRC IN 87-67.

4.3.5.2 Observations from Ginna and NMP-1

Ginna implements GALL Report AMP XI.S5 (Masonry Walls), combined with AMP XI.S6 (Structures Monitoring) and AMP XI.S7 (RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants), through its existing AMP B2.1.32, “Structures Monitoring Program.” NMP-1 implements this program through its existing “Masonry Wall Program,” AMP B2.1.27. Masonry walls are used as fire barriers at Ginna. Visual examination of masonry walls at Ginna is performed at 5-year intervals. Periodic inspections of the masonry walls at Ginna have not identified any significant degradation or cracking. Further details are available in the AEA TLR, ML13122A009.

The NMP-1 LRA states that its Masonry Wall Program manages aging effects so that the evaluation basis established for each masonry wall within the scope of license renewal remains valid through the PEO. The program requires periodic visual inspection of masonry walls in the scope of license renewal to detect loss of material and cracking of masonry units and mortar.

Inspections in 2005 indicated that the masonry walls at NMP-1 are generally in good physical condition, with only a few areas of minor degradation. Deficiencies were evaluated and appropriate corrective actions were taken. The most recent quarterly Health Reports for the program (July–September 2011) rated it as “Acceptable” and “Green.” The program appears to have no accessibility problems or repetitive observations.

4.3.5.3 Effectiveness of AMP XI.S5 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation. The criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.44, "AMP Worksheet XI.S5 Masonry Walls." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.5.4.

4.3.5.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. It was noted that the program description states that important elements in the evaluation of many masonry walls during the NRC IEB 80-11 program included (a) installation of steel edge supports to provide a sound technical basis for boundary conditions used in seismic analysis, and (b) installation of steel bracing to ensure stability or containment of unreinforced masonry walls during a seismic event. However, it does not mention removal of piping bearing force on the masonry wall, which is also a method of reinforcing the masonry wall in response to NRC IEB 80-11.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.S5, with exceptions and enhancements. The Ginna Structures Monitoring program includes inspection of masonry walls. The program identifies the structures and structural components within the scope of the maintenance rule and license renewal, the performance criteria that are to be monitored, and the frequency of inspections, and provides the controls to ensure that there is no loss of structure or structural component intended function.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.5.3.2 Effectiveness and Implementation of AMP XI.S5

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL program element states that trending is not required. On the contrary, trending is important and should be recommended. NMP-1 compares older checklists to recent checklists for trending and to the evaluation basis developed for the respective masonry wall during the resolution of IEB 80-11. These are considered as good practice for NMP-1.

4.3.5.4 Recommendations for Subsequent License Renewal

4.3.5.4.1 Good Practices or Strengths of AMP XI.S5

S5.S-1: *Recommendation*: The NMP-1 AMP requires that, following an unusual event such as an earthquake, a tornado, or flooding, an initial inspection should be conducted to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment. This is considered a strength of the NMP-1 AMP and is recommended for subsequent license renewal.
***Technical Basis*:** Inspecting masonry walls after an unusual event such as an earthquake, a tornado, or flooding would detect any further degradation caused by the event in a timely manner and would ensure the SSCs remain functional in the PEO.

4.3.5.4.2 Areas of AMP XI.S5 for Further Consideration/Enhancement

Program Description:

S5.0-1: *Recommendation*: Revise the program element to read as follows: "Important elements in the evaluation/modification of masonry walls during the NRC IEB 80-11 program included (a) installation of steel edge supports to provide a sound technical basis for boundary conditions used in seismic analysis, (b) installation of steel bracing to ensure stability or containment of unreinforced masonry walls during a seismic event, and (c) removal of piping bearing force on the wall."
***Technical Basis*:** The program description states that important elements in the evaluation of many masonry walls during the NRC IEB 80-11 program included (a) installation of steel edge supports to provide a sound technical basis for boundary conditions used in seismic analysis, and (b) installation of steel bracing to ensure stability or containment of unreinforced masonry walls during a seismic event. However, it does not mention removal of piping bearing force on the masonry wall, which is another of the methods to reinforce the masonry wall in response to NRC IEB 80-11.

S5.0-2: *Recommendation*: Add fire-barrier masonry walls to the program description and scope of program of AMP XI.M26, Fire Protection.
***Technical Basis*:** The GALL program description states that aging effects on masonry walls that are considered fire barriers also are managed by AMP XI.M26, Fire Protection. However, the program description and scope of program of AMP XI.M26, Fire Protection, does not include fire-barrier masonry walls.

1. Scope of Program:

S5.1-1: *Recommendation*: Enhance the scope of program by including components of masonry walls, as follows: "The program manages all of the masonry walls that are within the scope of 10 CFR 54.4, including those masonry walls applicable to the concerns of NRC IE-Bulletin 80-11, "Masonry Wall Design", and the walls that provide protection against fire per 10 CFR 50.48. The masonry wall consists of solid or hollow concrete block, mortar, grout, steel bracing, and supports."
***Technical Basis*:** Components of masonry wall are not defined in the scope of program.

2. Preventive Action:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

S5.3-1: *Recommendation*: Add parameters inspected for the structural steel of masonry (e.g., notable deflection or distortion, loose bolts, corrosion, and degradation of coating).
***Technical Basis*:** Structural steel is an integrated part of masonry wall. The GALL Report needs to recommend parameters monitored/inspected for structural steel of the masonry wall.

4. <u>Detection of Aging Effects</u>:

S5.4-1: *Recommendation*: Un-reinforced and unbraced masonry walls within the scope of license renewal should be inspected more frequently than reinforced masonry walls.
***Technical Basis*:** The GALL Report recommends that masonry walls should be inspected every 5 years. NMP-1 inspects un-reinforced and unbraced masonry walls more frequently, based on NRC's recommendation in the NMP-1 SER.

S5.4-2: *Recommendation*: Following a seismic event, an inspection should be conducted to assess conditions of the masonry walls and perform further evaluation if degradations are found.
***Technical Basis*:** Inspections after a seismic event are necessary to ensure the evaluation basis is not invalidated and the seismic capacity of the masonry wall is not degraded.

5. <u>Monitoring and Trending</u>:

S5.5-1: *Recommendation:* Older checklists should be compared to recent checklists for trending purposes and to verify whether there are any changes in the conditions of the masonry walls. The checklists should also be compared to the respective calculation developed for the respective masonry wall during the resolution of IEB 80-11.
***Technical Basis*:** The GALL program element states that trending is not required. On the contrary, trending is important and should be recommended. NMP-1 compares the older checklists to recent checklists for trending and to the evaluation basis developed for the respective masonry walls during the resolution of IEB 80-11. These are considered a good practice for NMP-1.

6. <u>Acceptance Criteria</u>:

S5.6-1: *Recommendation*: Acceptance criteria should be provided for the inspection of masonry walls. For example:

Each wall should be assessed against its design basis to confirm that aging effects of masonry walls (i.e., shrinkage and/or separation and cracking of masonry walls and gaps between the supports and masonry wall) have not significantly undermined the design basis assumptions.

Installation of any safety-related equipment near or adjacent to masonry walls requires additional evaluation against the original design basis.

For masonry wall serving as a fire barrier, any missing blocks, mortar, or cracks in the wall that cause a clear opening within the wall are considered unacceptable and require corrective action.

The applicable calculation (i.e., evaluation basis) for each masonry wall should be kept on record. If degradation of the wall or associated steel is judged significant or of concern, a review

of the respective calculation and further evaluation are performed to determine the effect on the evaluation basis.

In case of significant degradation of masonry walls, an acceptance criterion of “use-as-is” or “acceptable with deficiencies” is not considered acceptable, and continued use of the structure must be technically justified and validated by engineering analysis. If more sophisticated methods of analysis, such as finite element analysis, are used in the engineering analysis, it would be considered a new evaluation basis against seismic loads. The evaluation should consider the latest updated site seismic hazards.
***Technical Basis*:** The GALL program element is vague. These recommendations would provide more specific acceptance criteria.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

No further review item identified.

4.3.6 Structures Monitoring (XI.S6)

4.3.6.1 Objective and Scope of Rev. 2 AMP XI.S6

The objective of the program is to monitor the condition of structures and structural components within the scope of the Maintenance Rule (10 CFR 50.65) and license renewal, such that there is no loss of structure or structural component intended function during the extended period of operation. The AMP relies on the following AMAs:

(1) Periodic visual inspections by personnel qualified to monitor structures and components for applicable aging effects, as described in ACI 349.3R, ACI 201.1R, and ANSI/ASCE 11.

(2) Volumetric or surface examinations to detect SCC in high-strength (actual measured yield strength greater than or equal to 150 kilo-pounds per square inch [ksi] or greater than or equal to 1,034 MPa) structural bolts greater than 1 inch (25 mm) in diameter.

(3) Implement preventive actions delineated in NUREG-1339 and in EPRI NP-5769, NP-5067, and TR-104213 to ensure structural bolting integrity, if applicable.

(4) Periodic sampling and testing of groundwater and the need to assess the impact of any changes in its chemistry on below-grade concrete structures.

(5) Provide monitoring and maintenance for protective coatings that are relied upon to manage the effects of aging for any structures included in the scope of this AMP.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) Maintenance Rule (10 CFR 50.65);
(ii) ACI 349.3R, ACI 201.1R, and ANSI/ASCE 11; and
(iii) NUREG-1339, EPRI NP-5769, NP-5067, and TR-104213.

4.3.6.2 Observations from Ginna and NMP-1

Ginna implements this program through its AMP B2.1.32, "Structures Monitoring Program," and NMP-1 through its existing AMP B2.1.28, "Structures Monitoring Program." Further details are available in the AEA TLR, ML13122A009.

Observations at Ginna include:

- There is no indication of stoppage or debris in the leak chase channels of the spent-fuel pool because there is continuous flow of water. The leakage rate had been approximately 400 gallons per day. Some repairs prior to the audit reduced the leakage to approximately 200 gallon per day. In addition, no indication of leakage has been found in the accessible outside surfaces of the spent-fuel pool. Excavation performed outside near the pool for constructing the spent-fuel dry cask storage system also did not find any indication of leakage.

- Reactor cavity leakage has occurred during refueling outages at a rate of approximately 3 to 10 gallons per minute. Attempts to repair the leak have been unsuccessful.

NMP-1's Structures Monitoring Program provides for periodic visual inspections, surveys, and examination of all safety-related buildings (including the primary containment and substructures within the primary containment) and various other buildings. Further details are available in ML13122A009.

Groundwater leakage at NMP-1 appears to be seasonal, with persistent groundwater leakage in one location. The NMP-1 OpE (SER Section 3.0.3.3.21) states that minor cracking is present in various concrete structures, and slight (but stable) groundwater leaks in some tunnels. Several CRs have confirmed minor cracking in concrete structures, including the service water pipe tunnel, allowing leakage of groundwater. Groundwater also has entered switchgear building, service water tunnels, and the radwaste building of below-grade exterior walls. Previous tests at NMP-1 indicate the presence of chlorides at greater than 500 ppm, sulfate greater than 1500 ppm, and pH less than 5.5 in some wells. The licensee stated that these aggressive groundwater conditions are localized. Since 2008, chlorides have been observed to be out of specification six times, and sulfate only once. These locations were close to site roads where road salt is used during the winter**.**

Other observations of potential AMP technical and implementation weakness and other general observations from the audit of NMP-1's Structures Monitoring Program include:

- The AMP implementing procedure has personnel qualification requirements that are different from those in ACI 349.3R, which is cited in all revisions of the GALL Report. During the interview, the licensee stated that the requirements are comparable.
- The AMP implementing procedure states that submerged structures such as the intake tunnel are to be inspected, if possible. Previously, the licensee sent divers to inspect the

tunnel, and minor cracking was identified. The licensee is considering using a small remotely operated submarine-type vehicle to inspect the tunnel in the future.

- The licensee inspects structural components such as cable trays and conduit supports using the sampling technique described in EPRI NP-7218. This approach has not been observed at other plants.

No indications of fuel pool and reactor cavity leakage have been found.

4.3.6.3 Effectiveness of AMP XI.S6 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.45, "AMP Worksheet XI.S6 Structures Monitoring." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.6.4.

4.3.6.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

The AMPs implemented by both Ginna and NMP-1, and by most of the license renewal applicants in general, have been consistent with the GALL, Rev. 0, AMP XI.S6, with exceptions and enhancements. The Ginna Structures Monitoring program includes inspection of masonry walls and water-control structures. The program identifies the structures and structural components within the scope of the maintenance rule and license renewal, the performance criteria that are to be monitored, and the frequency of inspections, and provides the controls to ensure that there is no loss of structure or structural component intended function.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.6.3.2 Effectiveness and Implementation of AMP XI.S6

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) OpE indicates several cases of groundwater penetration/leakage:

  (i) An NRC 2011 inspection report revealed that groundwater penetration to underground electric tunnel at Seabrook plant caused concrete to lose more than 20% of its strength. The degradation is due to sulfate attack when concrete is saturated in water.

(ii) NMP-1 OpE (NMP-1 SER 3.0.3.2.21):

- Minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels.

- Several CRs have identified minor cracking in concrete structures, including the service water pipe tunnel, which is susceptible to small wall cracks allowing leakage of groundwater.

- Groundwater has also entered the switchgear building, service water tunnels, and the radwaste building through below-grade exterior walls.

This OpE indicates that, despite the guidance of the Structures Monitoring Program, groundwater leakage problems continue to be a problem at NMP-1.

4.3.6.4 Recommendations for Subsequent License Renewal

4.3.6.4.1 Good Practices or Strengths of AMP XI.S6

S6.S-1: *Recommendation*: The NMP-1 AMP requires that, following an unusual event such as an earthquake, a tornado, or flooding, an initial inspection should be conducted to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment. This is considered a strength of the NMP-1 AMP and is recommended for subsequent license renewal.
***Technical Basis*:** Conducting inspections after an unusual event such as an earthquake, a tornado, or flooding would detect any further degradation caused by the event in a timely manner and ensure the SSCs remain functional in the PEO.

4.3.6.4.2 Areas of AMP XI.S6 for Further Consideration/Enhancement

<u>Program Description</u>:

S6.0-1: *Recommendation*: Revise the AMP program description based on information contained RG 1.127, Rev. 2, when it has been officially approved.
***Technical Basis*:** Since the last revision of RG 1.127, several changes have been made to dam safety laws and to the requirements imposed on safety programs. The Draft Guide RG 1.127, Rev. 2, (NRC DG-1245) reflects current NRC positions and expectations for ISI programs and provides a summary of the main causes of dam failures and suggestions for preventive measures.

1. <u>Scope of Program</u>:

S6.1-1: *Recommendation*: Include surveys in the AMP as an additional method to detect aging effects. Examples of survey may include displacement of sliding surfaces, and seismic gaps between buildings. The scope of surveys, parameters for monitoring, survey methods, frequency of survey, acceptance criteria, and corrective actions should be included in the AMP.
***Technical Basis*:** The NMP-1 SER, Section 3.0.3.2.21 (Structures Monitoring Program), states that the program provides for visual inspections and <u>surveys</u>, and examination of all building and structures within the scope of license renewal. In addition to visual inspection, survey is a method of detecting aging effects. The GALL AMP does not include surveys in the scope of program.

S6.1-2: *Recommendation*: The aging effects/mechanisms due to DEF, as well as preventive measures, should be included in this AMP.
***Technical Basis*:** If concrete is exposed to substantial amounts of water for extended periods, DEF may occur, leading to volume expansion, the destructive expansive forces of which crack the concrete. DEF was first reported in heat-cured railway ties in Germany in the early 1980s. Since then, several other countries including the United States have reported DEF problems in concrete structures (DOT News Letter, July 2004).

S6.1-3: *Recommendation*: Enhance the current guidance for aging management of components in inaccessible areas by including the following items: (1) When "serious degradation in inaccessible areas" in an area of concern for this plant, as identified from other utility plant inspections. (2) Components in inaccessible areas include buried concrete, embedded steel, and structural components blocked by installed equipment or structures.
***Technical Basis*:** The Ginna Structure Monitoring AMP includes buried concrete, embedded steel, and structural components blocked by installed equipment or structures. Ginna's AMP considered the two items mentioned above in managing aging effects for the components in inaccessible areas.

2. <u>Preventive Action</u>:

S6.2-1: *Recommendation*: Provide preventive actions for stopping or mitigating groundwater penetration/leakage based on industry practice and literature search.
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. The GALL Report could suggest preventive actions for stopping or mitigating groundwater penetration/leakage based on industry practice and literature search (e.g., painting of the structural surfaces).

S6.2-2: *Recommendation*: The aging effects/mechanisms due to DEF, and preventive measures, should be included in this AMP.
***Technical Basis*:** Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate to aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment (Naus, NUREG/CR-6927).

3. <u>Parameters Monitored/Inspected</u>:

S6.3-1: *Recommendation*: Include parameters monitored for survey, such as displacements of sliding surfaces and seismic gaps between buildings.
***Technical Basis*:** The NMP-1 SER, Section 3.0.3.2.21 (Structures Monitoring Program), states that the program provides for visual inspections and surveys, and examination of all building and structures within the scope of license renewal. If survey is in the scope of the AMP, parameters of the survey need to be specified.

S6.3-2: *Recommendation*: Include parameters monitored/inspected for DEF in the AMP.
***Technical Basis*:** The combination of aging effects/mechanisms due to DEF is not included in the AMP of GALL, Rev. 2, related to concrete structures. Excessive heat curing that decomposes the ettringite in Portland cement during the hydration process causes this degradation. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, the destructive expansive forces of which crack the concrete.

S6.3-3: *Recommendation*: Monitor the amount of building settlement and differential settlement based on NRC IN 97-11 and IN 98-26 and add the two INs to the AMP reference section.
***Technical Basis*:** NRC IN 97-11 and IN 98-26 recommend examination of structures and interfaces between structures, when accessible, for signs of building settlement and/or differential settlement. If examinations of structure settlement are performed, the amount of settlement needs to be monitored.

S6.3-4: *Recommendation*: Include the following parameters for monitoring and inspection, especially water in-leakage.

For concrete structures: water in-leakage, spalling, cracking, delaminations, honeycombs, chemical leaching, peeling paint, discoloration.

Structural steel: corrosion, peeling of paints, deformed beam and column, loose or missing anchors and fasteners, missing or degraded grout under base plate cracked welds.
Structural bolting: cracking, corrosion, loss of preload.
***Technical Basis*:** The GALL program element states that for concrete structures, parameters monitored include loss of material, cracking, increase in porosity and permeability, loss of foundation strength, and reduction in concrete anchor capacity due to local concrete degradation. It does not include water in-leakage, which appears to be a common problem due to groundwater penetration/leakage.

4. Detection of Aging Effects:

S6.4-1: *Recommendation*: Change the interval of groundwater sampling from "not to exceed 5 years" to "not to exceed 6 months" in order to promptly identify changes of groundwater chemistry.
***Technical Basis*:** The technical basis includes the following:

(1) The GALL Report states that groundwater quality is monitored on a frequency not to exceed 5 years. The 5-year interval may not be adequate, considering seasonal variation and winter salting, to ensure that a benign environment is maintained.

(2) NRC IE Bulletin 80-11 requires the Licensee to establish a routine sampling/analysis or monitoring program for these systems in order to promptly identify any contaminating events that could lead to unmonitored, uncontrolled liquid or gaseous releases to the environment, including releases to on-site leaching fields or retention ponds.

    In response to NRC IE Bulletin 80-11, NMP-1 has nine wells and performs routine sampling/analysis of groundwater conditions to identify any radioactive contamination in the groundwater. The groundwater of NMP-1 is sampled at least once every 6 months for corrosive indicators in the scope of the NMP-1 Structures Monitoring Program.

(3) Most plants have groundwater wells in place and frequently monitor groundwater quality in response to NRC IE bulletin 80-11 (e.g., the 6-month interval in the NMP-1 groundwater monitoring program).

S6.4-2: *Recommendation*: Include the method of survey for detection of aging effects such as changes in the displacement of sliding surfaces and shrinkage of seismic gaps between buildings.

***Technical Basis*:** Displacement of sliding surfaces and seismic gaps between buildings can change due to differential settlements, and building settlements in seismic events. Periodic survey would ensure these aging effects are detected in a timely manner.

S6.4-3: *Recommendation*: Include detection of aging effects due to DEF in the Detection of Aging Effects program element.
***Technical Basis*:** The combination of aging effects/mechanisms due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures. Excessive heat curing that decomposes the ettringite in Portland cement during the hydration process causes this degradation. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, the destructive expansive forces of which crack the concrete.

S6.4-4: *Recommendation*: Enhance the program element by adapting the inspection intervals in the NMP-1 AMP, including the following:

For SSCs with no degradation or defects identified in the baseline inspection, the inspection interval should not exceed 24 months.

For SSCs with evidence of degradation requiring corrective actions, or that may require future restoration, an appropriate monitoring frequency is established based on the function and degraded conditions of the SSCs.

For degradation not requiring corrective actions, the conditions of the degraded areas are monitored at each refueling cycle for a period of at least three cycles.
***Technical Basis*:** The GALL Report states that, in general, all structures and groundwater quality are monitored on a frequency “not to exceed 5 years.” The 5-year inspection interval could be too long for subsequent license renewal. The 24-month interval for the inspection of SCCs with no degradation appears reasonable. For degradation not requiring corrective actions, the conditions of the degraded areas are monitored at each refueling cycle for a period of at least three cycles; this is considered a good practice for NMP-1.

S6.4-5: *Recommendation*: An initial inspection should be conducted after an unusual event such as an earthquake, a tornado, or flooding, to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment.
***Technical Basis*:** The NMP-1 AMP requires that, following an unusual event such as an earthquake, a tornado, or flooding, an initial inspection should be conducted to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment. This is considered a strength of the NMP-1 AMP.

S6.4-6: *Recommendation*: The GALL Report states that “Qualifications of inspection and evaluation personnel specified in ACI 349.3R are acceptable for license renewal.” The GALL statement should be changed to “Qualifications of inspection and evaluation personnel specified in ACI 349.3R or qualifications equivalent to the requirements specified in the ACI 349.3R are acceptable for license renewal.”
***Technical Basis*:** The NMP-1 Audit Report states that the structures monitoring program implementing procedure has personnel qualification requirements that are different from the ones in the ACI 349.3R. During the interview, the licensee stated that the requirements are comparable, and GALL recommendations are not mandatory.

S6.4-7: *Recommendation:* Maintain and continuously update the baseline data of previous inspections.
***Technical Basis*:** The NMP-1 Audit Report indicates that the licensee does not maintain and continuously update the baseline data of previous inspections. The licensee stated that the inspectors review previous CRs of two previous outages before walkdowns to identify any specific areas of concern.

S6.4-8: *Recommendation*: Follow up with NMP-1 later to find out how successfully the use of a small remotely operated submarine-type vehicle was implemented and lessons learned for providing guidance on inspections of underwater intake tunnel and other water systems using a small, remotely operated submarine-type vehicle.
***Technical Basis*:** The NMP-1 preliminary AEA report implementing procedure states that submerged structures such as the intake tunnel should be inspected if possible. This is vague. The tunnels for the essential water systems run all the time and cannot be emptied out. Previously, the licensee sent divers to inspect the tunnel and identified minor cracking in the tunnels. Now the licensee is planning to use small, remotely operated submarine-type vehicles to inspect the underwater tunnel. If this is successful, this procedure will be very useful at other plants that have the same issues.

S6.4-9: *Recommendation*: Groundwater quality monitoring should not exceed 6 months, because winter salting and seasonal variations may affect groundwater chemistry.
***Technical Basis*:** The GALL Report states that, in general, all structures and groundwater quality are monitored on a frequency not to exceed 5 years. The NMP-1 preliminary AEA report states that NMP-1 monitors groundwater for chemical substances every 6 months. Previous tests indicate chlorides greater than 500, sulfate greater than 1500, and pH less than 5.5 in some wells. The licensee stated that this is localized. Even if the high chloride and sulfate content is localized, it may degrade below-grade structures and indicates that groundwater chemistry monitored on a frequency not to exceed 5 years is not adequate.

5. <u>Monitoring and Trending</u>:

S6.5-1: *Recommendation*: Add “trending amount of water leaked due to groundwater penetration/leakage” as a parameter for managing the groundwater leakage problem. The parameter could be water leaked, measured in gallons/day.
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. The amount of water leakage is an effective parameter for trending.

S6.5-2: *Recommendation:* Change the name of the program element to just “Trending” to emphasize the importance of performing trending. All of Ginna’s AMPs provide trending reports at a 6-month interval. The Ginna trending reports are considered very effective in aging management. This could be a global change in GALL.
***Technical Basis*:** Monitoring is already considered in the Parameters Monitored/Inspected program element. There is no need to repeat it here. This program element should just emphasize trending and provide more guidance on trending (e.g., trending every 6 months) and document the trending results, because trending is important for aging management.

S6.5-3: *Recommendation:* Groundwater leakage appears to be a common problem in structures and tunnels (e.g., groundwater leakage in the Seabrook plant). Guidance should be provided on management of groundwater leakages in structures and tunnels.
***Technical Basis*:** The NMP-1 preliminary AEA report states that there is persistent groundwater leakage in some structures. These structures are visually inspected and monitored for

degradation. The persistent groundwater leakage illustrates a need to provide guidance on management of groundwater leakage.

6. <u>Acceptance Criteria</u>:

S6.6-1: *Recommendation:* Provide acceptance criteria of groundwater quality, such as, "If chloride, sulfate, or pH levels exceed an established maximum allowable changes threshold, condition report and evaluation should be initiated."
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. The program element does not contain acceptance criteria of groundwater quality.

S6.6-2: *Recommendation*: Investigate and add quantitative acceptance criteria such as allowable concrete crack widths based on ACI codes in the GALL Report. For applicants that are not committed to ACI 349.3R and elect to use plant-specific criteria for concrete structures, it should also describe the quantitative acceptance criteria of concrete crack width.
***Technical Basis*:** The NMP-1 Draft AEA Report states that the NMP-1 walkdown checklist does not contain any specific quantitative criteria in accordance with ACI 349.3R. GALL, Rev. 2, states that applicants that are not committed to ACI 349.3R and elect to use plant-specific criteria for concrete structures should describe the criteria and technical basis for deviation from those in ACI 349.3R.

S6.6-3: *Recommendation*: Add "establishing acceptance criteria of groundwater leakage in the Plant Technical Specification" to the program element.
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. Acceptance criteria of the amount of water leakage allowed in a time period should be established in the Plant Technical Specification.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S6.10-1: *Recommendation*: Rewrite this program element and add recent OpE from Seabrook and NMP-1. In addition, a literature search in the NRC database should be performed to find additional cases of OpE.
***Technical Basis*:** The OpE provided in this section is outdated. It does not contain enough OpE from recent years. For examples, see the cases below.

(a) A NRC 2011 inspection report revealed that groundwater penetration to underground electric tunnel at Seabrook plant caused concrete to lose more than 20% of its strength. The degradation is due to sulfate attack when the concrete is saturated in water.

(b) NMP-1 OpE (SER 3.0.3.2.21):

- Minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels have been found.

- Several CRs have identified minor cracking in concrete structures, including the service water pipe tunnel, which is susceptible to small wall cracks that allow leakage of groundwater.

- Groundwater has also entered the switchgear building, service water tunnels, and the radwaste building through below-grade exterior walls.

This OpE indicates that groundwater penetration/leakage into structures is a severe problem and the Structures Monitoring Program may not be effective in dealing with the groundwater leakage problems.

4.3.7 RG 1.127, Inspection of Water-Cooled Structures Associated with Nuclear Power Plants (XI.S7)

4.3.7.1 Objective and Scope of Rev. 2 AMP XI.S7

The objective of the program is to provide guidelines for aging management of water-control structures associated with NPPs, such as dams, slopes, canals, and other raw water-control structures associated with emergency cooling water systems or flood protection.

To ensure the aging effects of the water-control structures are managed during the PEO, the AMP relies on the following AMAs:

(1) Perform ISI and surveillance for water-control structures in accordance to NRC RG 1.127.

(2) Incorporate preventive measures recommended in NUREG-1339, EPRI TR-104213, EPRI NP-5067, and EPRI NP-5769 to ensure structural bolting integrity.

(3) Evaluate the inspection results and conditions of the significant changes. The evaluation includes a technical assessment of the causes of distress or abnormal conditions, evaluation of the behavior or movement of the structure, and recommendations for remedial or mitigating measures.

(4) Consider NRC NUREG-1522, which describes instances of and corrective actions for severely degraded steel and concrete components at the intake structure and pump house of coastal plants, as well as appreciable leakage from the spillway gates, concrete cracking, corrosion of spillway bridge beam seats and cooling canal, and appreciable differential settlement.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) NRC RG 1.127;
(ii) NUREG-1339, EPRI TR-104213, EPRI NP-5067, and EPRI NP-5769; and
(iii) NRC NUREG-1522.

4.3.7.2 Observations from Ginna and NMP-1

Ginna implements this program through AMP B2.1.32, “Structures Monitoring Program.” Ginna water-control structures include the circulating water system discharge canal, the canal interface with the pump screen house, and a stone revetment that protects the site from storm surge flooding. No earthen water-control structures are used at Ginna. The Ginna LRA stated that large armor stones are used in the revetment, which underwent a site-specific review by the U.S. Army Corps of Engineers (Corps) in the review of Systematic Evaluation Program topics II-3.A, II-3.B, and II-3.C, “Hydrology, Flooding, and Ultimate Heat Sink.” The Structures Monitoring Program and Periodic Surveillance and Preventive Maintenance program execute the recommendations made by the Corps by performing surveys and inspections of the armor stone and cap rocks to ensure that erosion and stone movement do not compromise the functionality of the water-control structure.

This program is not being used at NMP-1; instead, underwater inspections are performed as a repetitive task as part of the NMP-1 Periodic Surveillance and Preventive Maintenance Program. The Periodic Surveillance and Preventive Maintenance Program also inspects for silting and fouling of water-control structures. Divers and submarine-mounted cameras are

used to inspect the underwater surfaces of the screen house, discharge canal, canal valves, and weir gates, and the intake tunnels and structure. Results of these inspections are reviewed by qualified engineers as part of the Structures Monitoring Program. Concrete used in water-control structures has been evaluated for the aging mechanisms of freeze-thaw, leaching of calcium hydroxide, reaction with aggregates, corrosion of embedded steel, aggressive chemical attack, settlement, and abrasion.

4.3.7.3 Effectiveness of AMP XI.S7 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.46, “AMP Worksheet XI.S7 RG 1.127, Inspection of Water-Cooled Structures Associated with Nuclear Power Plants.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.7.4.

4.3.7.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) In view of the Fukushima event, flood protection walls and gates should be included in the AMP. These items are not included in the program description.

The Ginna water-control structures include the circulating water system discharge canal, the canal's interface with the pump screen house, and a stone revetment that protects the site from surge flooding. The water-control structure inspections are performed in accordance with the Periodic Surveillance and Preventive Maintenance Program and the Structures Monitoring Program. Inspections of water-control structures in NMP-1 is part of the Structures Monitoring Program.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.7.3.2 Effectiveness and Implementation of AMP XI.S7

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL program description states that for plants not committed to NRC RG 1.127, Rev. 1, aging management of water-control structures may be included in the “Structures

Monitoring" (AMP XI.S6) program element. Even if a plant is committed to NRC RG 1.127, Rev. 1, aging management of certain structures and components may be included in "Structures Monitoring" (AMP XI.S6). It is not clear which structures and components can be included in the Structures Monitoring AMP. For plants committed to RG 1.127, all water-control structures and components should be included in this AMP, not in the Structures Monitoring AMP. This would simplify the GALL Report and provide focus to the aging management of flood-protection walls and gates to ensure these structures continue to function during earthquake or flooding events in the PEO.

(b) Groundwater penetration/leakage occurs frequently in plants. It could become more severe as plants get older. Examples of recent OpE of groundwater penetration/leakage include the following:

(i) A NRC 2011 inspection report revealed that groundwater penetration to an underground electric tunnel at Seabrook caused concrete to lose more than 20% of its strength. The degradation is due to sulfate attack when the concrete is saturated in water.

(ii) NMP-1 OpE (SER 3.0.3.2.21):

- Minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels were found.

- Several CRs have identified minor cracking in concrete structures including the service water pipe tunnel, which is susceptible to small wall cracks that allow leakage of groundwater.

- Groundwater has also entered the switchgear building, service water tunnels, and the radwaste building through below-grade exterior walls.

This OpE indicates that the effectiveness of the XI. S7, Inspection of the Water-Control Structures, may need to be improved to deal with groundwater penetration/leakage.

Aging management should be addressed in dealing with groundwater penetration/leakage and providing guidelines using the lessons learned from Seabrook and other OpE.

4.3.7.4 Recommendations for Subsequent License Renewal

4.3.7.4.1 Good Practices or Strengths of AMP XI.S7

S7.S-1: *Recommendation*: The NMP-1 AMP requires that, following an unusual event such as an earthquake, a tornado, or flooding, an initial inspection should be conducted to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment. This is considered a strength of the NMP-1 AMP and is recommended for subsequent license renewal.
***Technical Basis*:** Conducting inspections after an unusual event such as an earthquake, a tornado, or flooding would detect any further degradation caused by the event in a timely manner and ensure the SSCs remain functional in the PEO.

4.3.7.4.2 Areas of AMP XI.S7 for Further Consideration/Enhancement

<u>Program Description</u>:

S7.0-1: *Recommendation*: The AMP program description should be revised based on information contained in RG 1.127, Rev. 2, when it has been officially approved.
***Technical Basis*:** Since the last revision of RG 1.127, several changes have been made to dam safety laws and to the requirements imposed on safety programs. The Draft Guide RG 1.127, Rev. 2 (NRC DG-1245), reflects current NRC positions and expectations for ISI programs and provides a summary of the main causes of dam failures and suggestions for preventive measures.

1. <u>Scope of Program</u>:

S7.1-1: *Recommendation*: Include flood protection walls and gates in the scope of the program and provide guidance on aging management of flood protection walls and gates.
***Technical Basis*:** In view of the Fukushima event, the flood-protection walls and gates are essential water-control structures.

S7.1-2: *Recommendation*: The aging effects/mechanisms due to DEF, and preventive measures, should be included in this AMP.
***Technical Basis*:** If concrete is exposed to substantial amounts of water for extended periods, DEF may occur, leading to volume expansion, the destructive expansive forces of which crack the concrete. DEF was first reported in heat-cured railway ties in Germany in the early 1980s. Since then, several other countries including the United States have reported DEF problems in concrete structures (DOT News Letter, July 2004).

S7.1-3: *Recommendation*: The current guidance for aging management of components in inaccessible areas should include the following items: (1) When "serious degradation in inaccessible areas" that is an area of concern for this plant is identified from other utility plant inspections. (2) Components in inaccessible areas include buried concrete, embedded steel, and structural components blocked by installed equipment or structures.
***Technical Basis*:** The Ginna Structure Monitoring AMP includes buried concrete, embedded steel, and structural components blocked by installed equipment or structures. Ginna considered the two items mentioned above in their AMP in managing aging effects for the components in inaccessible areas.

2. <u>Preventive Action</u>:

S7.2-1: *Recommendation*: Provide preventive actions for stopping or mitigating groundwater penetration/leakage based on industry practice and literature search.
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. The GALL Report could suggest preventive actions for stopping or mitigating groundwater penetration/leakage based on industry practice and literature search (e.g., painting of the structural surfaces).

S7.2-2: *Recommendation*: The aging effects/mechanisms due to DEF, and preventive measures, should be included in the AMPs.
***Technical Basis*:** Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate-to-aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment (Naus, NUREG/CR-6927).

S7.2-3: *Recommendation:* Add preventive measures for dam failures based on Draft Guide DG-1245.

***Technical Basis*:** The proposed Rev. 2 of RG 1.127 (i.e., Draft Guide DG-1245) reflects current NRC positions and expectations for ISI programs of the water-control structures. It provides a summary of the main causes of dam failures and suggests possible preventive measures for dam failures.

3. <u>Parameters Monitored/Inspected</u>:

S7.3-1: *Recommendation*: The AMP should include parameters monitored/inspected for DEF.
***Technical Basis*:** The combination of aging effects/mechanisms due to DEF is not included in the AMP of GALL, Rev. 2, related to concrete structures. Excessive heat curing that decomposes the ettringite in Portland cement during the hydration process causes this degradation. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, the destructive expansive forces of which crack the concrete.

S7.3-2: *Recommendation*: Include the following parameters for monitoring and inspection, especially <u>water in-leakage.</u>

For concrete structures: water in-leakage, spalling, cracking, delaminations, honeycombs, chemical leaching, peeling paint, discoloration.

Structural steel: corrosion, peeling of paints, deformed beam and column, loose or missing anchors and fasteners, missing or degraded grout under base plate cracked welds.
Structural bolting: cracking, corrosion, loss of preload.
***Technical Basis*:** The GALL program element states that for concrete structures, parameters monitored include loss of material, cracking, increase in porosity and permeability, loss of foundation strength, and reduction in concrete anchor capacity due to local concrete degradation. It does not include <u>water in-leakage,</u> which appears to be a common problem due to groundwater penetration/leakage.

4. <u>Detection of Aging Effects</u>:

S7.4-1: *Recommendation*: Include detection of aging effects due to DEF in the Detection of Aging Effects program element.
***Technical Basis*:** The combination of aging effects/mechanisms due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures. Excessive heat curing that decomposes the ettringite in Portland cement during the hydration process causes this degradation. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, the destructive expansive forces of which crack the concrete.

S7.4-2: *Recommendation*: An initial inspection should be conducted after an unusual event such as an earthquake, a tornado, or flooding, to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment.
***Technical Basis*:** The NMP-1 AMP requires that, following an unusual event such as an earthquake, a tornado, or flooding, an initial inspection should be conducted to assess conditions of the affected SSCs. A complete structural inspection may be required depending on the assessment. This is considered a strength of the NMP-1 AMP.

5. <u>Monitoring and Trending</u>:

S7.5-1: *Recommendation*: Add "trending amount of water leaked due to groundwater penetration/leakage" as a parameter for managing the groundwater leakage problem. The parameter could be water leaked, measured in gallons/day.
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. The amount of water leakage is an effective parameter for trending.

S7.5-2: *Recommendation:* Change the name of program element to just "Trending" to emphasize the importance of performing trending. All of Ginna's AMPs provide trending reports at 6-month intervals. The Ginna trending reports are considered very effective in aging management. This could be a global change in the GALL Report.
***Technical Basis*:** Monitoring is already considered in the "Parameters Monitored/Inspected" program element. There is no need to repeat it here. This program element should just emphasize trending and provide more guidance on trending (e.g., trending every 6 months and documenting the trending results), because trending is important for aging management.

6. <u>Acceptance Criteria</u>:

S7.6-1: *Recommendation*: Add "establishing acceptance criteria of ground water leakage in the Plant Technical Specification" to the program element.
***Technical Basis*:** Groundwater penetration/leakage could be a severe problem as plants get older. Acceptance criteria of the amount of water leakage allowed in a time period should be established in the Plant Technical Specification.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S7.10-1: *Recommendation*: Add the cases of dam failures based on the Draft Guide RG 1.127, Rev. 2 (NRC DG-1245).
***Technical Basis*:** NRC DG-1245 reflects current NRC positions and expectations for ISI programs and provides a summary of the main causes of dam failures and suggestions for preventive measures.

4.3.8 Protective Coating Monitoring and Maintenance Program (XI.S8)

4.3.8.1 Objective and Scope of Rev. 2 AMP XI.S8

The objective of the program is to proper maintain the protective coatings inside containment (described as Service Level 1 in NRC RG 1.54, Rev. 2) to ensure that paint chips or flakes do not dislodge in a post-accident environment and cause unacceptable containment sump blockage in the ECCS suction strainers, which reduces flow through the system and could cause unacceptable head loss for the pumps as described in GL 98-04.

To ensure operability of post-accident safety systems that rely on water recirculated through the containment sump during the PEO, the AMP relies on the following AMAs:

(1) Performing in-service coating visual inspection and monitoring for Service Level I protective coatings in accordance with EPRI Report 1019157 and ASTM D 5163-08, which identifies the parameters monitored or inspected for any visible defects, such as blistering, cracking, flaking, peeling, rusting, and physical damage. The minimum scope of the program is Service Level I coatings applied to steel and concrete surfaces inside containment (e.g., steel liner, steel containment shell, structural steel, supports, penetrations, and concrete walls and floors), defined in NRC RG 1.54, Rev. 2. Protective coatings for steel containments and steel liners for concrete containments are subject to the requirements of Subsection IWE of the ASME Code, Section XI.

(2) Evaluation of the inspection report in accordance with the acceptance criteria in ASTM D 5163-08 or other equivalent codes for future surveillance or repair, and prioritization of repairs.

(3) Considering NRC IN 88-82, NRC BL 96-03, GL 04-02, and GL 98-04, which describe industry experience pertaining to coatings degradation inside containment and the consequential clogging of sump strainers.

Thus, the AMP relies on the requirements or guidance from the following documents, among others listed in the program description:
(i) ASTM D 5163-08;
(ii) EPRI Report 1019157;
(iii) Subsection IWE of the ASME Code, Section XI
(iv) NRC RG 1.54, Rev. 2; and
(v) NRC IN 88-82, NRC Bulletin 96-03, GL 04-02, and GL 98-04.

4.3.8.2 Observations from Ginna and NMP-1

Ginna implements this program through AMP B2.1.24, “Protective Coatings Monitoring and Maintenance Program,” and NMP-1 through AMP B2.1.38, “Protective Coating Monitoring and Maintenance Program”. Ginna has done extensive work related to a generic safety issue (GSI) regarding the clogging of containment emergency sumps. The audit determined that there were 11 coatings-related CRs included in the Ginna LR CR Trending Documents. Numerous other cases of containment liner corrosion were discovered. The causes of these instances of corrosion included degraded coatings, degraded moisture barrier seals, or water accumulation from various sources such as condensation from the internal air condition on the liner surface. The inspection of coatings is performed at each refueling outage (every 18 months). The inspection conducted in 2009 indicated that the total amount of degraded containment coatings

was 223 ft^2, or less than 25% of the total amount permitted to ensure post-accident operability of the emergency core-cooling system (ECCS) suction strainers.

The NMP-1's Protective Coating Monitoring and Maintenance Program is an existing program that applies to Service Level I protective coatings inside the primary containment and items within the torus (outside surface of the vent (ring) header and downcomer, inside surface of the vent piping, ring header, vent header junctions, and downcomers).

In the 2011 coatings inspection, it was found that the total amount of failed coating available for transport to the ECCS suction strainers was conservatively estimated at about 52.6 lb., which is below the allowed 85 lb. in design calculations. There have been no dramatic changes during the three previous outages.

Further details are available in the AEA TLR, ML13122A009.

4.3.8.3 Effectiveness of AMP XI.S8 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.47, "AMP Worksheet XI.S8 Protective Coating Monitoring and Maintenance Program." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.8.4.

4.3.8.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The GALL, Rev. 2, XI.S8 program only addresses maintenance of protective coatings inside containment (i.e., Service Level 1 protective coating). The Ginna interviewees suggested adding SL-III (Safety Related Coatings Outside of Containment) to the AMP.

(b) The AMP touches upon but does not discuss in detail the concerns raised in NRC GSI-191, which deals with the clogging of containment emergency sumps and its consequences due to debris, including failed coatings, created during a design-basis accident. It would be helpful to more explicitly highlight the concerns of GSI-191 (and reference GSI-191 directly) in the program description.

(c) Ginna interviewees suggested careful updating the AMP including, but not limited to, ASTM D7230-06, Standard Guide for Evaluating Polymeric Lining Systems for Water Immersion in Coating Service Level III Safety-Related Applications on Metal Substrates, July 1, 2006.

The AMPs implemented by both Ginna and NMP-1 was consistent with the GALL, Rev. 0, AMP XI.S8, with no exceptions and enhancements. Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.8.3.2 Effectiveness and Implementation of AMP XI.S8

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

4.3.8.4 Recommendations for Subsequent License Renewal

4.3.8.4.1 Good Practices or Strengths of AMP XI.S8

No specific good practice was identified during the review.

4.3.8.4.2 Areas of AMP XI.S8 for Further Consideration/Enhancement

Program Description:

No specific items identified.

1. Scope of Program:

S8.1-1: *Recommendation*: Expand the scope of program to include SL-III (Safety Related Coatings Outside of Containment) in the scope of the AMP.
***Technical Basis*:** Ginna interviewees suggested inclusion of both SL I coatings and SL III coatings. As stated in Rev. 2 of RG 1.54, Service Level III coatings are used in areas outside the reactor containment where failure could adversely affect the safety function of a safety-related SSC.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

S8.4-1: *Recommendation*: EPU effects (e. g., containment temperature, pressure, pH and radiation dose) should be taken into consideration to ensure the qualification test methods used in the AMP are effective in detecting the aging effects of containment protective coatings.
***Technical Basis*:** In 2006, the NRC carefully reviewed the EPU effect on protective coating systems (per the NRR SG and Chem Eng Branch input to Section 2.1.7 of the SER) and concluded that Ginna appropriately addressed the impact of changes in conditions following a design-basis LOCA and their effects on these organic materials. The NRC staff further concluded that the licensee has demonstrated that conditions following the implementation of the proposed EPU (in terms of containment temperature, pressure, pH and radiation dose) will continue to be bounded by qualification test conditions. Therefore, the NRC staff finds the

proposed EPU acceptable with respect to protective coating systems and other organic materials.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.3.9 Concrete Containment Tendon Prestress (TLAA X.S1)

4.3.9.1 Objective and Scope of Rev. 2 TLAA X.S1

The objective of the program is to maintain the tendon prestress above the minimum required value (MRV) in accordance with NRC RG 1.35, Rev. 3, to ensure that the structural and functional adequacy of a prestressed containment are maintained in the PEO.

To ensure the adequacy of prestressing forces in prestressed concrete containment tendons during the PEO, the AMP relies on the following AMAs:

(1) Performing inspection and measurement of tendon prestressing forces in accordance with the requirements of Subsection IWL of the ASME Code, Section XI, supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii).

(2) Performing assessment of the inspection and measurement results in accordance with NRC RG 1.35, Rev. 3, which consists of predicted lower limit (PLL) and the minimum required prestressing force, also called MRV.

(3) Establishes trending lines in accordance with NRC IN 99-10:

> The goal is to keep the trending line above the PLL because, as a result of any inspection perform in accordance with ASME Section XI, Subsection IWL, if the trend line crosses the PLL, the existing prestress in the containment could go below the MRV soon after the inspection and would not meet the requirements of 10 CFR 50.55a(b)(2)(ix)(B) or 10 CFR 50.55a(b)(2)(viii)(B).

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) Subsection IWL of the ASME Code, Section XI, supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii);
(ii) NRC RG 1.35, Rev. 3, July, 1990; and
(iii) NRC IN 99-10.

4.3.9.2 Observations from Ginna and NMP-1

Ginna has a prestressed concrete containment. Ginna implements AMP B3.3, “Concrete Containment Tendon Prestress,” to manage its TLAAs related to containment tendon prestress. This program is not applicable to NMP-1, which has a steel containment. Further details are available in the AEA TLR, ML13122A009.

Ginna retensioned 23 of the 160 vertical tendons 1,000 h after initial prestressing. Subsequent tests determined that the tendon lift-off forces were generally lower than the predicted values. The investigation concluded that the accelerated loss of lift-off forces was caused by stress relaxation of the tendon wires. Tendon stress relaxation tests conducted at Lehigh University, in preparation for the installation of fiber optic strain gages on 20 of the 160 tendon locations, indicated that this stress relaxation over time was caused by the increase in temperature from ambient conditions to operating conditions.

In the license renewal SER (NUREG-1786), the NRC staff found that evaluation of the structural integrity test results would reveal if there is a gross change in the containment behavior, which would, in turn, indicate significant degradation of the inaccessible components in the containment. Other observations from the audit include:

- The Ginna containment is unique from a regular prestressed concrete containment. The vertical tendons are anchored at the base to rock anchors by bellows. In addition, there are neoprene pads embedded in the concrete at the base and spring line of containment. This unique design required some additional surveillance requirements for the prestressing tendons and containment pressure tests.

The strain gauges that were installed at 20 of the 160 tendon locations to measure the tendon forces and possible loss of prestress were installed for research purposes. The lift-off testing of 14 random tendons every 5 years that is required by the current AMP will continue.

4.3.9.3 Effectiveness of TLAA X.S1 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.48, “AMP Worksheet X.S1 Concrete Containment Tendon.” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.9.4.

4.3.9.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The program description and the program elements in the GALL do not mention the aging mechanisms that cause loss of tendon prestress.

The AMP implemented by Ginna and NMP-1 is consistent with the GALL, Rev. 0, AMP X.S1, with no exceptions and enhancements.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.9.3.2 Effectiveness and Implementation of TLAA X.S1

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Program Element 4, “Detection of Aging Effects,” does not contain sufficient information for detection of aging effects such as frequency of measurement of tendon prestressing forces.

(b) Program Element 10, “Operating Experience,” provides a reference paper by H. Asher et al. regarding OpE of loss of tendon prestress. However, no detailed information from the paper

is provided in the AMP. Users of the GALL Report may have no access to the reference paper and thus ignore the reference.

4.3.9.4 Recommendations for Subsequent License Renewal

4.3.9.4.1 Good Practices or Strengths of TLAA X.S1

S9.S-1: *Recommendation*: Ginna performs two SITs during the PEO (SER commitment item 27) to verify performance of the lower portion of the prestress containment. This is considered a strength of Ginna's AMP. The SITs should be included in the subsequent license renewal.
***Technical Basis*:** The SIT measurements consist of radial and vertical deformations and visual observations during and after the tests. The comparison will allow the applicant to detect significant deviation from the containment expected behavior. The SITs would verify the behavior of the containment in the lower portion of the containment. Evaluation of the test results would indicate whether there is a gross change in the containment behavior, which would indicate significant degradation of the inaccessible components in a prestress containment such as tendon bellows, elastomer pads, and radial tension bars.

S9.S-2: *Recommendation*: Include "measurements of the tendon forces and retension of the tendons if necessary prior to the end of current license period" as a requirement in the AMP for subsequent license renewal. This is to ensure that prestressing forces remain above the MRV during the subsequent license renewal.
***Technical Basis*:** The Ginna TLAA for the evaluation of loss of prestress in containment tendons concluded that the initial retensioned set of 23 tendons should be retensioned prior to the end of the current licensing period to ensure that prestressing forces remain above the MRV during the PEO.

4.3.9.4.2 Areas of TLAA X.S1 for Further Consideration/Enhancement

<u>Program Description</u>:

S9.0-1: *Recommendation*: Consider providing aging mechanisms for loss of tendon prestress in the program description. The aging mechanisms include stress relaxation, shrinkage, creep, and elevated temperature. The information is missing in the program description.
***Technical Basis*:** The tendon stress relaxation test program that was conducted at the Fritz Engineering Laboratory of Lehigh University indicated that stress relaxation of the tendon wires was the most significant cause for the lower-than-predicted tendon forces.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

S9.2-1: *Recommendation*: Revise the program element by adding installation of strain gages on tendons as a preventive action.
***Technical Basis*:** Ginna installs strain gages on tendons. Tendon strain gages would detect loss of tendon prestress in a timely manner and prevent further loss of prestress.

S9.2-2: *Recommendation*: Treat "retension of the tendons experienced loss of prestress in the current license term prior to the end of current license period" as a requirement for subsequent license renewal.
***Technical Basis*:** The Ginna TLAA for the evaluation of loss of prestress in containment tendons concluded that the initial retensioned set of 23 tendons should be retensioned prior to the end of the current licensing period to ensure that prestressing forces remain above the MRV during the PEO.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

S9.4-1: *Recommendation*: Add the following statement: "The loss of containment tendon prestressing forces due to stress relaxation, shrinkage, creep, and elevated temperature is detected by the program."
***Technical Basis*:** The GALL program element does not mention the aging mechanisms of loss of tendon prestress. Stress relaxation has been identified as the most significant factor for loss of tendon prestress.

S9.4-2: *Recommendation*: Add the required frequency in measuring the tendon prestress in accordance with the requirements of Subsection IWL of the ASME Code, Section XI, as supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii).
***Technical Basis*:** Providing guidance on frequency of measurement of tendon prestress is to ensure aging effects of the tendon can be detected in a timely manner.

S9.4-3: *Recommendation*: Add more details about the detection of aging effects based on RG 1.35 and other documents, such as the requirement that at least 4% of the population of each tendon group be randomly sampled during each surveillance.
***Technical Basis*:** RG 1.35 requires that at least 4% of the population of each tendon group be randomly sampled during each surveillance. The GALL program element needs to contain such information to ensure unexpected tendon degradation can be detected in a timely manner.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

S9.10-1: *Recommendation*: Add Ginna OpE indicating that temperature is an important effect in tendon stress relaxation.
***Technical Basis*:** The Ginna SER (NUREG-1786) states that an increase in temperature from ambient conditions to operating conditions significantly increases the amount of stress relaxation over time. For example, at a temperature of 104°F, after 40 years the stress relaxation in the tendon would be expected to be as high as 21%, as opposed to 12% as originally predicted. This is useful OpE information and could help tendon inspection by focusing on tendons in the containment areas exposed to higher temperatures.

S9.10-2: *Recommendation*: Add essential OpE information from the paper by H. Asher to the program element.
***Technical Basis*:** The GALL program element has provided a reference paper by Asher on OpE related to loss of tendon prestress. However, no detailed information is provided in the program element regarding the OpE. Users of the GALL may have no access to the reference paper and thus ignore the reference.

4.3.10 NMP-1 Drywell Supplemental Inspection Program (Plant-Specific)

4.3.10.1 Objective and Scope of the Drywell Supplemental Inspection AMP

The objective of this plant-specific program at NMP-1 is to provide AMAs for managing the aging effects of the areas that have major rust on the drywell shell underneath the drywell coolers. To ensure that the aging effects of the drywell shell are managed in the PEO, the AMP relies on the following AMAs:

(1) Perform volumetric examinations on the drywell shell during the refueling outage in accordance with ASME IWE requirements and perform engineering evaluations to determine the actions necessary for NMP-1 operation through the PEO, in accordance with the NMP-1 Drywell Supplemental Inspection Program.

(2) Establish the acceptance criteria based on the calculated corrosion rate (mil/years), margin to design thickness (mils) and the projected wall thickness at the end of extended operation. Depending on corrosion rate, intervals between UT measurement range from 2 years to 10 years.

(3) Monitor the shell thickness to ensure pressure boundary function is maintained through the PEO.

Thus, the AMP relies on the requirements or guidance from the following documents:
(i) ASME IWE; and
(ii) NMP-1 Drywell Supplemental Inspection Program.

4.3.10.2 Observations from NMP-1

The “Drywell Supplemental Inspection Program” at NMP-1 is a plant-specific program that managed aging effects at six localized areas of the drywell shell that have suffered corrosion in the past. These six areas are located near and underneath the drywell coolers at the 225-ft elevation. The degradation was due to the use of chemicals for cleaning the coils of the drywell coolers, which was discontinued once the degradation was realized. Further details are available in the AEA TLR, ML13122A009.

UT measurements were performed in 2007 and 2009 to establish a trend in the loss of thickness, which was virtually nil due to the containment being nitrogen-inerted during operation. After measurements, the six areas were cleaned and recoated with a two-part epoxy Carboline coating. This epoxy coating will be monitored by the Service Level I Coatings AMP and the drywell will continue to be inspected under the ASME Section XI IWE AMP (which has the same action requirements as the Drywell Supplemental Inspection Program); however, the plant-specific “Drywell Supplemental Inspection Program” has now been discontinued.

NMP-1 has established the detailed acceptance criteria based on the calculated corrosion rate (mil/years), margin to design thickness (mils), and the projected wall thickness at the end of extended operation. Depending on the calculated corrosion rate, UT measurements are performed at intervals ranging from 2 to 10 years.

4.3.10.3 Effectiveness of Drywell Supplemental Inspection to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the

AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.49, "AMP Worksheet NMP-1 Drywell Supplemental Inspection Program (Plant-Specific)." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.10.4.

4.3.10.3.1Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.10.3.2Effectiveness and Implementation of the Drywell Supplemental Inspection AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) NMP-1 has established the detailed acceptance criteria based on the calculated corrosion rate (mil/years), margin to design thickness (mils) and the projected wall thickness at the end of extended operation.

4.3.10.4 Recommendations for Subsequent License Renewal

4.3.10.4.1Good Practices or Strengths of the Drywell Supplemental Inspection AMP

S10.S-1: ***Recommendation*****:** Clean the area cooler as a preventive action to prevent corrosion for the dry well shell near and underneath the coolers and sand pocket region.
Technical Basis: NMP-1 performs cleaning of the area coolers in maintenance procedures to provide prevention corrosion for the dry well shell near and underneath the coolers and sand pocket region. The GALL program element could contain cleaning of the area coolers in maintenance procedures as a preventive action.

4.3.10.4.2Areas of the Drywell Supplemental Inspection AMP for Further Consideration/Enhancements

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

S10.2-1: *Recommendation*: Include preventive actions in the AMP, such as providing painting for the drywall surfaces and performing cleaning of the area coolers during maintenance procedures.
Technical Basis: The disposition of NMP-1 CR NM-2006-1276 indicates that preventive actions need to be included in the AMP to stop or mitigate corrosion in the drywall. As a result of LR challenge Board, it was determined that there were no preventive actions contained in CR-2003-1080 (see above) of the drywell at 225-ft elevation.

Disposition: Revise N1-NMP-201-550 to provide preventive actions.

S10.2-2: *Recommendation*: Include cleaning of the area coolers during maintenance procedures as a preventive action to prevent corrosion for the dry well shell near and underneath the coolers and sand pocket region.
Technical Basis: For Mark I steel containment, NMP-1 cleaning of the area coolers during maintenance procedures could provide prevention corrosion for the dry well shell near and underneath the coolers and sand pocket region. The GALL program element could contain cleaning of the area coolers during maintenance procedures as a preventive action.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. <u>Operating Experience</u>:

No further review item identified.

4.3.11 NMP-1 Torus Corrosion Monitoring Program (Plant-Specific)

4.3.11.1 Objective and Scope of the Torus Corrosion Monitoring AMP

The objective of this plant-specific program at NMP-1 is to provide AMAs for managing the aging effects of the torus wall and torus external support structures. To ensure that the aging effects of the torus wall and supporting structures are managed in the PEO, the AMP relies on the following AMAs:

(1) Torus UT measurements: The six thinnest (average thickness) previously identified locations on the torus shell are measured approximately once every year.

(2) Torus coupon analysis: The program provides for torus coupons weight and thickness analysis in accordance with ASTM G1, 1990, to measure corrosion loss in estimating the corrosion rate of the torus shell. The corrosion rate and data from the UT measurements are evaluated for further action.

(3) Torus external support structure visual inspection: Visual inspection is performed for corrosion and any visible deficiency of the torus support columns, the saddles, and earthquake tie rods. Any corrosion and deficiency will be evaluated.

Thus, the AMP relies on the requirements or guidance from the following document:
(i) ASTM G1, 1990.

4.3.11.2 Observations from NMP-1

The Torus Corrosion Monitoring Program at NMP-1 is an existing plant-specific AMP used to obtain and analyze NMP-1 torus wall thickness data for use in establishing the torus shell material ongoing corrosion rate and shell wall thickness. When NMP-1 torus corrosion was found in 1993, NMP submitted the “Torus Corrosion Monitoring Program,” which included a “Torus UT Measurement Program” and “Torus Coupon Analysis Program,” to the NRC for review and approval. Further details are available in the AEA TLR, ML13122A009.

The licensee changed the inspection frequency commitment through its commitment evaluation process, consistent with the NRC-endorsed NEI 99-04 commitment change process. The licensee determined that the corrosion rate in the torus had been less than what was assumed in the SER and that adequate margin exists for the minimum required wall thickness of 0.431 in. The licensee basis for this change is that corrosion rate in August 1994 UT examination was 1.243 mils/year. This rate gradually decreased to 0.801 mils/year in 2004. In 2011, the corrosion rate was 0.313 mils/year. However, these corrosion rates do not agree with corrosion rates obtained from the coupons, which was found to be 0.462 mils/year at the last outage. The methodology for the determination of the loss rate from one RFO to the next and the projection for when the minimum Torus wall thickness will be reached is in accordance with the NRC-approved “Torus Corrosion Monitoring Program.”

In summary, NMP-1 has established the detailed acceptance criteria based on the calculated corrosion rate (mil/years), margin to design thickness (mils), and the projected wall thickness at the end of extended operation. However, the UT measurements are performed on the pre-selected areas with known thinnest average wall thickness.

4.3.11.3 Effectiveness of the Torus Corrosion Monitoring AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.50, "AMP Worksheet NMP-1 Torus Corrosion Monitoring Program (Plant-Specific)." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are listed in Subsection 4.3.11.4.

4.3.11.3.1Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This assessment did not identify any items of specific concern.

Information on possible effects of plant modifications on this AMP was not evaluated in this TLR.

4.3.11.3.2Effectiveness and Implementation of the Torus Corrosion Monitoring AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) NMP-1 has established the detailed acceptance criteria based on the calculated corrosion rate (mil/years), margin to design thickness (mils) and the projected wall thickness at the end of extended operation.

(b) The UT measurements are performed on the pre-selected areas with known thinnest average wall thickness. This may overlook unexpected corrosion in some other areas. UT thickness measurements should also be performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell (e.g., pitting corrosion).

4.3.11.4 Recommendations for Subsequent License Renewal

4.3.11.4.1Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

4.3.11.4.2Areas of the Torus Corrosion Monitoring AMP for Further Consideration/Enhancements

<u>Program Description</u>:

No further review item identified.

1. Scope of Program:

S11.1-1: ***Recommendation*:** UT thickness measurements should also be performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell (e.g., pitting corrosion).
Technical Basis: The UT measurements are performed on the pre-selected areas with known thinnest average wall thickness. This may overlook unexpected corrosion in some other areas.

2. Preventive Action:

S11.2-1: ***Recommendation*:** Add coating on the inside of the torus shell as a preventive measurement.
Technical Basis: The torus shell of NMP-1 is not coated and little margin is left on the wall thickness based on the NMP-1 Draft AEA report.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

S11.4-1: ***Recommendation*:** UT thickness measurements should also be performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell (e.g., pitting corrosion).
Technical Basis: The UT measurements are performed on pre-selected areas with known thinnest average wall thickness. This may overlook unexpected corrosion in some other areas.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.4 AMPs for Electrical Systems

4.4.1 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (XI.E1)

4.4.1.1 Objective and Scope of AMP XI.E1

The objective of this AMP is to provide reasonable assurance that the intended function of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse local environments caused by heat, radiation or moisture will be maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

4.4.1.2 Observations from Ginna and NMP-1

The Ginna "Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements" program does not limit the program to adverse localized environments but is structured to identify any such areas that may exist in the plant spaces subject to an AMR. Further details are available in the AEA TLR, ML13122A009.

The walk downs performed at Ginna consisted of non-intrusive visual inspection and temperature measurement (infrared) of accessible cables, with photographs taken as required. The walk downs included in-scope and out-of-scope components located in the identified locations. No significant changes were noted to the AMP with regard to operating experience, NRC requirements, or power uprate.

The inspections at Ginna identified four cases where debris was found on cable jackets. The cable jackets were noted to be in good condition. Analysis of the debris by the applicant concluded that material degradation was unlikely. The applicant also generated three CRs that identified suspect damaged cable jackets, and improper cable wrapping (tape). A review of trends in CRs from September 24, 2008, through March 31, 2011, listed the above corrective actions with no indication of increasing trends.

The NMP-1 LRA states that AMP B2.1.29, "Non-EQ Electrical Cables and Connections Program," is a new program that is consistent with GALL AMP XI.E1, "Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements." Further details are available in ML13122A009.

NMP-1 manages cable and connection aging by the identification of adverse localized environments and the use of visual inspections of in-scope accessible cable and connections jacket material to identify cable and connection jacket (insulation) degradation that may result in cable and connection loss of insulation resistance and loss of continuity. The results of the accessible cable and connections inspection are considered representative of the inaccessible cables and connections. Unacceptable conditions are evaluated and a determination is made as to whether the same condition is applicable to other accessible and inaccessible cables or connections.

The NMP-1 inspection identified adverse localized environments and three condition reports were initiated. No unanticipated or premature component degradation was noted in the

inspection results. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results.

4.4.1.3 Effectiveness of AMP XI.E1 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the "program description" and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, "XI.E1 Cables and Connections." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 4.4.1.4.

4.4.1.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. . The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated. The definition of accessible may need further clarification.

4.4.1.3.2 Effectiveness and Implementation of AMP XI.E1

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

4.4.1.4 Recommendations for Subsequent License Renewal

4.4.1.4.1 Good Practices or Strengths of the AMP

E1.S-1: *Recommendation*: Based on the staff effectiveness audits, the applicant's Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements program is capable of identifying adverse localized environments and identifying affected in-scope cables during the period of extended operation. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results. The applicant's gap analysis for extending this program beyond 60 years did not identify any major program changes required for operation beyond 60 years.

4.4.1.4.2 Areas of the AMP for Further Consideration/Enhancements

<u>Program Description</u>:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

E1.3-1: *Recommendation*: The definition of accessible may need further clarification. ***Technical Basis*:** This program depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. (G3, N1) GALL states for plants or areas that have no accessible cable for visual inspection, this program would not apply and cable in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated.

4. Detection of Aging Effects:

E1.4-1: *Recommendation*: The definition of accessible may need further clarification. ***Technical Basis*:** GALL states for plants or areas that have no accessible cable for visual inspection, this program would not apply and cable in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

E1.6-1: *Recommendation*: The definition of accessible may need further clarification. ***Technical Basis*:** GALL states for plants or areas that have no accessible cable for visual inspection, this program would not apply and cable in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.4.2 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits (XI.E2)

4.4.2.1 Objective and Scope of the AMP

The objective of this AMP is to provide reasonable assurance that the intended functions of electrical cables and connections (that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are used in instrumentation circuits with sensitive, high-voltage, low-level current signals exposed to adverse localized environments caused by temperature, radiation, or moisture) are maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a performance monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

4.4.2.2 Observations from Ginna and NMP-1

In response to an NRC request for additional information during the review of the Ginna LRA, the applicant concluded that visual inspection for mechanical aging defects for these circuits is appropriate, but also stated that they perform periodic insulation resistance testing on these circuits, which would continue into the PEO. The applicant ultimately implemented an AMP to perform insulation resistance testing in addition to visual inspections.

Ginna work orders reviewed indicated test performance anomalies but were not inconsistent with expected results. Three corrective actions were noted including a loose connector, disparity between detector readings, and display repair. Work orders were initiated and repetitive tasks established. The audit did not identify any adverse trends.

The NMP-1 LRA states that AMP B2.1.30, “Non-EQ Electrical Cables and Connections Used in Instrumentation Circuits Program,” is an existing program. Results for the 10 year period reviewed concluded that cable systems were in acceptable condition. Cable failures were stated to be due to moisture intrusion, connection makeup or connection contamination. The applicant stated that inspection of failure sites did not indicate breakdown of the insulation or jacket.

Further details are available in the AEA TLR, ML13122A009.

4.4.2.3 Effectiveness of AMP XI.E2 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the “program description” and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, “XI.E2 Cables Used in Instrumentation Circuits” The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 4.4.2.4.

4.4.2.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. . The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E2 may need to be evaluated. The definition of accessible may need further clarification.

4.4.2.3.2 Effectiveness and Implementation of AMP XI.E2

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

4.4.2.4 Recommendations for Subsequent License Renewal

4.4.2.4.1 Strengths of AMP XI.E2

E2.S-1: *Recommendation*: Based on the staff effectiveness audits, the applicant's counterpart to XI.E2 program is capable of identifying adverse localized environments and identifying affected in-scope cables during the period of extended operation. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results. The applicant's gap analysis for extending this program beyond 60 years did not identify any major program changes required for operation beyond 60 years.

One suggestion was to consider a redefinition of accessible cables and connections in the context of walkdowns.

4.4.2.4.2 Areas of AMP XI.E2for Further Consideration/Enhancements

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.4.3 Inaccessible Power Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (XI.E3)

4.4.3.1 Objective and Scope of AMP (XI.E3)

The objective of this AMP is to provide reasonable assurance that the intended functions of inaccessible or underground power cables that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to wetting or submergence are maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a condition monitoring program. However, periodic actions are taken to prevent inaccessible cables from being exposed to significant moisture, such as identifying and inspecting in-scope accessible cable conduit ends and cable manholes for water collection, and draining the water, as needed.

4.4.3.2 Observations from Ginna and NMP-1

The Ginna LRA identified four medium-voltage power cables installed in underground duct banks but determined that the failure of these cables would not prevent the satisfactory accomplishment of any intended function and concluded that there were no inaccessible medium voltage cables within the scope of license renewal. The staff agreed with the scoping for these medium-voltage cables but questioned the exclusion of additional cables from license renewal aging management. The applicant subsequently included the additional medium voltage cables in the scope of license renewal and provided a new aging management program.

The initial testing of in-scope cables medium-voltage cable at Ginna was completed with no issues noted.

This AMP is not applicable for NMP-1 because there are no non-EQ inaccessible medium voltage cables within the scope of license renewal for Unit 1, as documented in procedure NER-1E-026. This program is applicable to NMP Unit 2.

Subsequently, NMP-1 has initiated condition reports to implement a low voltage power cable aging management program. In addition, a procedure has been developed for low voltage cable and medium voltage cable. Although not directly tied to the increased scope of GALL AMP XI.E3 in Revision 2 of the GALL Report (e.g., adding low voltage power cable), the applicant has identified an increased scope of inaccessible power cable aging management by adding medium (three cables identified for NMP-1) and low voltage power cable based on plant-specific and industry operating experience, industry guidance, and NRC communication (IN).

Further details are available in the AEA TLR, ML13122A009.

4.4.3.3 Effectiveness of AMP XI.E3 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the “program description” and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, “XI.E3

Inaccessible Medium Voltage Cables." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 4.4.1.4.

4.4.3.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This AMP applies to all inaccessible or underground (e.g., in conduit, duct bank, or direct buried) power cables (greater than or equal to 400 volts) within the scope of license renewal exposed to adverse environments, primarily significant moisture. Significant moisture is defined as periodic exposures to moisture that last more than a few days (e.g., cable wetting or submergence in water). Submarine or other cables designed for continuous wetting or submergence are not included in this AMP. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E3 may need to be evaluated.

4.4.3.3.2 Effectiveness and Implementation of AMP XI.E3

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

4.4.3.4 Recommendations for Subsequent License Renewal

4.4.3.4.1 Strengths of AMP XI.E3

E1.S-1: *Recommendation*: Based on the staff effectiveness audits, the applicant's "Inaccessible Medium Voltage Cables" applies to inaccessible medium voltage cable not subject to the EQ requirements of 10 CFR 50.49 and within the scope of license renewal that are exposed to significant moisture simultaneously with significant voltage. Aging management is performed by testing. The scope of XI.E3 is currently inaccessible power cables equal to or greater than 480V. Consideration should be given to whether future versions of XI.E3 scope should include lower voltages (0 to 1000 V power cable).

4.4.3.4.2 Areas of AMP XI.E3for Further Consideration/Enhancements

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

E3.1-1: *Recommendation*: Consideration should be given to whether future versions of XI.E3 scope should include lower voltages (0 to 1000 V power cable).

***Technical Basis*:** The scope of XI.E3 is currently only inaccessible power cables equal to or greater than 400V. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E3 may need to further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified

4.4.4 Metal-Enclosed Bus (XI.E4)

4.4.4.1 Objective and Scope of AMP XI.E4

The objective of this AMP is to provide an internal and external inspection of Metal Enclosed Buses (MEBs) to identify age-related degradation of insulating material (i.e., porcelain, xenoy, thermoplastic organic polymers), and metallic and elastomer components (e.g., gaskets, boots, and sealants). As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

4.4.4.2 Observations from Ginna and NMP-1

Since the GALL Report, Rev. 0, did not include AMP XI.E4, Ginna originally addressed the aging management of the in-scope electrical bus components as a one-time inspection. In response to staff questions and industry operating experience during review of the Ginna LRA, the applicant committed to include additional periodic joint resistance testing credited under the B2.1.23 Periodic Surveillance and Preventive Maintenance program (as shown in Table A.5).

The NMP-1 LRA identifies AMP B2.1.34, "Non-Segregated Bus Inspection Program," as an existing plant-specific program with enhancements. The AMP periodically inspects the material and components internal to in-scope non-segregated bus duct.

The applicant's program depends on internal inspection of MEBs to identify age related degradation of insulating material (i.e., porcelain, xenoy, thermoplastic organic polymers) and metallic and elastomeric components (e.g., gaskets, boots, and sealants). For Ginna, the implementing procedures and associated work orders noted acceptable inspection results with no unanticipated component degradation or inconclusive results noted. The inspection at NMP-1 was performed with satisfactory results with one CR generated for a loose bolt and incorrect use of washers on one connection.

4.4.4.3 Effectiveness of AMP XI.E4 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the "program description" and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, "XI.E4 Non-Segregated Bus." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 4.4.4.4.

4.4.4.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on internal and external inspection of Metal Enclosed Buses (MEBs) to identify age-related degradation of insulating material (i.e., porcelain, xenoy,

thermoplastic organic polymers), and metallic and elastomer components (e.g., gaskets, boots, and sealants).

4.4.4.3.2 Effectiveness and Implementation of AMP XI.E4

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

4.4.4.4 Recommendations for Subsequent License Renewal

4.4.4.4.1 Strengths of AMP XI.E4

E4.S-1: *Recommendation*: Based on the staff effectiveness audit at NMP-1, the applicant's counterpart to XI.E4 is capable of inspecting the material and components internal to in-scope non-segregated bus duct.

4.4.4.4.2 Areas of AMP XI.E4for Further Consideration/Enhancements

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.4.5 Fuse Holders (XI.E5)

4.4.5.1 Objective and Scope of AMP XI.E5

The objective of this AMP is to provide reasonable assurance that the intended function of the metallic clamps of fuse holders are maintained consistent with the current licensing basis through the period of extended operation. It manages fuse holders (metallic clamps) located outside of active devices that are considered susceptible to the following aging effects: increased resistance of connection due to chemical contamination, corrosion, and oxidation or fatigue caused by ohmic heating, thermal cycling, electrical transients, frequent manipulation, or vibration. Fuse holders inside an active device (e.g., switchgear, power supplies, power inverters, battery chargers, and circuit boards) are not within the scope of this AMP. As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

4.4.5.2 Observations from Ginna and NMP-1

As discussed below for each plant, this AMP is not implemented at either Ginna or NMP-1.

Because GALL AMP XI.E5 was not included in Revision 0 of the GALL Report, this AMP was not addressed by the Ginna LRA. Based on staff questions concerning potential in-scope fuse holder aging mechanisms and effects during its review of the Ginna LRA, the applicant reviewed in-scope fuse holders and concluded that these fuse holders are not subject to the aging mechanisms or effects identified by the staff. The staff accepted the applicant's evaluation in its SER.

The NMP-1 plant-specific fuse holder inspection program monitors fuse holder parameters, including high resistance of the fuse holder metallic clamp to detect fatigue caused by moisture, ohmic heating, mechanical stress, vibration, thermal cycling, electrical transients, chemical contamination, oxidation, and corrosion. The fuse holder inspection program tests the metallic portion of the fuse holder using thermography, contact resistance testing, or other appropriate testing methods. The inspections are performed every 10 years with the initial inspection performed prior to the PEO.

The NMP LRA scoped in fuse holders consistent with 10 CFR 54.4(a)(3). However, all 259 fuses identified as associated with systems within the scope of license renewal and not part of an active assembly screened out as not requiring aging management. This AMP was not implemented based on subsequent scoping and screening of in-scope fuse holders.

4.4.5.3 Effectiveness of AMP XI.E5 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the "program description" and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, "XI.E5 Fuse Program." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations

for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 4.4.1.4.

4.4.5.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on testing at least once every 10 years to provide an indication of the condition of the metallic clamp of the fuse holder. Testing may include thermography, contact resistance testing, or other appropriate testing methods.

4.4.5.3.2 Effectiveness and Implementation of AMP XI.E5

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

4.4.5.4 Recommendations for Subsequent License Renewal

4.4.5.4.1 Strengths of AMP XI.E5

E4.S-1: *Recommendation*: Based on the staff effectiveness audits, on applicants' counterparts to the Fuse Holders AMP, suggestions were made to capture new equipment and fuse holders and reconfirm that aging mechanisms and original conclusions that aging effects associated within-scope fuse holders do not require aging management remains valid. The applicant's gap analysis for extending this program beyond 60 years identified this as a new program with a 10-year inspection cycle.

4.4.5.4.2 Areas of AMP XI.E5for Further Consideration/Enhancements

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.4.6 Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (XI.E6)

4.4.6.1 Objective and Scope of AMP XI.E6

The objective of this AMP is to provide reasonable assurance that the intended function of the metallic parts of electrical cable connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and susceptible to age-related degradation resulting in increased resistance of connection due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation are maintained consistent with the current licensing basis through the period of extended operation. Cable connections associated with cables within the scope of license renewal that are external connections terminating at active or passive devices, are in the scope of this AMP. Wiring connections internal to an active assembly are considered part of the active assembly and, therefore, are not within the scope of this AMP. This AMP does not include high-voltage (>35 kilovolts) switchyard connections. The cable connections covered under the Environmental Qualification (EQ) program are not included in the scope of this program. As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

4.4.6.2 Observations from Ginna and NMP-1

The GALL Report electrical connections program XI.E6 (metallic portion of the connection) and associated aging mechanisms were not addressed in the GALL Report, Rev. 0, and were not addressed by Ginna in its LRA (see Table A.5). The metallic portion of connections as a component is not addressed in GALL AMP XI.E1, which manages the insulated portion of cables and connectors. GALL Report Rev. 0 evaluated electrical connectors not subject to 10 CFR 50.49 EQ requirements that are exposed to borated water leakage. This program is not handled under a GALL Report electrical AMP but is addressed separately under the Ginna program that relates to GALL AMP XI.M10, “Boric Acid Corrosion.”

The NMP-1 LRA describes AMP B2.1.39, “Non-EQ Electrical Cable Metallic Connection Inspection Program,” as a new plant-specific program. The program addresses the aging effects of the metallic parts used to connect cable conductors to other cable or components. Connections include splices (butt of bolted connections), crimp type, and terminal blocks. The aging stressors associated with these connectors and addressed by this program include: thermal cycling, ohmic heating, electrical transients, electrical transients, vibration, chemical contamination, corrosion, and oxidation. This AMP was included in the NMP LRA due to development of AMP XI.E6, “Electrical cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements,” in Revision 1 of the GALL Report.

The audit identified no changes to this AMP based on operating experience. All testing met the acceptance criteria with no findings or corrective actions initiated. AMP implementation did not find aging effects for the sample connections selected.

4.4.6.3 Effectiveness of AMP XI.E6 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices

or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified into the "program description" and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, "XI.E6 Electrical Connections Program - Metallic." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 4.4.6.4.

4.4.6.3.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on one-time testing to verify that increased resistance of connection due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation is not an aging effect that requires periodic testing.

4.4.6.3.2 Effectiveness and Implementation of AMP XI.E6

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

4.4.6.4 Recommendations for Subsequent License Renewal

4.4.6.4.1 Strengths of AMP XI.E6

E6.S-1: *Recommendation*: Based on the staff effectiveness audits, the applicants' counterpart to AMP XI.E6 tests the aging (loosening of connection) of the metallic portion of electrical connections. The program tests the increased resistance of connection aging effect associated with the following aging mechanisms: thermal cycling, ohmic heating, electrical transients, electrical transients, vibration, chemical contamination, corrosion, and oxidation

4.4.6.4.2 Areas of AMP XI.E6for Further Consideration/Enhancements

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

4.4.7 Environmental Qualification of Electrical Equipment (TLAA X.E1)

4.4.7.1 Objective and Scope of Rev. 2 TLAA X.E1

The objective of EQ AMP program is to manage thermal, radiation and cyclical aging for electrical equipment. For license renewal, plant EQ programs that implement the requirements of 10 CFR 50.49 are considered AMPs for license renewal. Under 10 CFR 54.21(c)(1)(iii), the effects of aging on the intended functions will be adequately managed for the period of extended operation. Reanalysis of the EQ program aging evaluation completed under 10 CFR 50.49(e) is part of the EQ program. The aging reanalysis considered important attributes including analytical method, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions. If the qualification of component cannot be extended, that component is refurbished, replaced, or re-qualified prior to exceeding the current qualification term (qualified life).

4.4.7.2 Observations from Ginna and NMP-1

The Ginna "Environmental Qualification Program" is established for compliance with 10 CFR Part 50, Appendix A, Criterion 4, and 10 CFR 50.49, and is an existing AMP. The EQ program manages component thermal, radiation, and cyclical aging based on 10 CFR 50.49(f). The Ginna EQ AMP describes the aging management associated with environmentally qualified electrical equipment within the scope of license renewal. This program is considered a TLAA for license renewal. The TLAA is applicable for EQ components with a qualified life of greater than 40 years. The applicant performed a confirmatory analysis to verify existing analyses were adequate for the PEO. The PBD described activities related to the Ginna EPU project, noting that the environmental conditions were recalculated for normal and accident conditions. The engineering report evaluating EQ for the extended uprate project was provided during the audit. EQ equipment, including equipment identified as a TLAA for license renewal, were evaluated based on the extended power uprate environmental conditions. The Ginna Procedure EP-3-P-0139 established and implemented the license renewal commitment while LRTA-01 summarizes the evaluation of EQ electrical equipment for extended operation.

The NMP-1 "Environmental Qualification Program" is an existing program that is consistent with GALL Report AMP X.E1, "Environmental Qualification (EQ) of Electric Components." The EQ program demonstrates that certain electrical components located in harsh environments (subject to the harsh environmental effects of a LOCA, high-energy line breaks, or post-LOCA environment) are qualified to perform their safety function when subjected to a harsh environment after the effects of in-service aging. The effects of significant aging mechanisms are addressed as part of EQ, including the replacement or refurbishment components not qualified for the license term prior to the end of designated life. Qualification may also be extended prior to reaching the components qualified life. Aging evaluations for EQ components that specify a qualified life of at least 40 years are considered TLAAs for license renewal. Procedure revisions were implemented for the re-evaluation of a components qualified life from 40 to 60 years.

Further details are available in the AEA TLR, ML13122A009.

4.4.7.3 Effectiveness of TLAA XE1 to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from visits to Ginna and NMP-1 were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the

AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR.

As explained in Section 4.4.7.2, the Ginna EQ Program is established by 10 CFR Appendix A, Criterion 4 and 10 CFR 50.49, and is considered an existing AMP.

The NMP-1 Environmental Qualification Program is an existing program that is consistent with GALL Report AMP X.E1, "Environmental Qualification (EQ) of Electric Components". .

4.4.7.3.1 Adequacy of the Program Description

The adequacy of the program description was determined to be adequate.

4.4.7.3.2 Effectiveness and Implementation of TLAA X.E1

The effectiveness of the AMP and the results of the AMP implementation audits were evaluated and determined to be adequate. This program depends on site specific evaluations to verify thermal, radiation and cyclical aging for electrical equipment subject to 10 CFR 50.49 is being managed and in-scope equipment is replaced before the end of its qualified life.

4.4.7.4 Recommendations for Subsequent License Renewal

4.4.7.4.1 Good Practices or Strengths of TLAA X.E1

***Recommendation*:** Based on the staff effectiveness audits, and the applicants' counterpart to AMP X.E1 there are no recommended enhancements to this AMP.

4.4.7.4.2 Areas of TLAA X.E1 for Further Consideration/Enhancement

<u>Program Description</u>:

No further review item identified.

1. <u>Scope of Program</u>:

No further review item identified.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

SECTION 5
Evaluation of AMP Effectiveness at the H.B. Robinson Steam Electric Plant

5.1 Overview

In this Section, we provide detailed information on the various AMP effectiveness audit (AEA) technical areas and evaluation of the effectiveness as observed. The focus is on the additional information gained from this third AEA, rather than an overview of what is in NUREG-1801 AMPs. Thus there is proportionately more focus on the industry AMP, rather than the NUREG-1801 AMP and the subsection titles such as *5.2.1.1 Objective and Scope of the AMP* reference the AMP in general, rather than just the specific NRC AMP. The overview Subsection provides a summary of the audits from H. B. Robinson Steam Electric Plant, Unit 2 and results from these audits.

On April 19, 2004, the U.S. Nuclear Regulatory Commission (NRC) granted a renewed operating license for an additional twenty years of operation from July 31, 2010, to July 31, 2030, to the H. B. Robinson Steam Electric Plant, Unit 2 (HBRSEP, termed RNP in the remainder of this report). The NRC staff completed an aging management program (AMP) effectiveness audit at RNP between January 8 and January 10, 2013. The NRC staff reviewed the implementation of RNP AMPs for license renewal since RNP entered the period of extended operation. This audit was supported by the Argonne National Laboratory.

Prior to the AMP audit, the licensee provided an internet portal to facilitate the NRC audit team access to relevant documents. The audit team reviewed the implementing procedure documents, inspection reports, and program basis documents associated with the RNP AMPs. The portal also provided the licensee's self-assessment of AMPs such as the Program Health Reports. During the audit, the NRC staff team further reviewed additional documents, as for example: the action requests and work orders related to the implementation and corrective actions for each AMP. The audit team also interviewed the licensee personnel responsible for the performance of AMPs.

Table 3.1 tabulates all the NUREG-1801 AMPs and their counterparts at RNP. As shown in Table 3.1, AMPs that were covered at Ginna and NMP-1 but were not at RNP include XI.S5 masonry walls (covered as part of the RNP Structures Monitoring (B3.15) AMP. Appendix B provides a full list of NRC participants and RNP interviewees and documents reviewed before, during, and after the site visit.

The NRC staff held a final briefing with the licensee on January 10, 2013, to discuss the preliminary findings of the audit. The audit team provided general observations regarding RNP's implementation of the AMPs and the audit process:

The licensee performed a gap analysis to identify the difference in the RNP AMPs and the AMPs described in "Generic Aging Lessons Learned (GALL) Report (NUREG-1801)," Revision 2, for some of the AMPs.

The NRC identified areas in some of their programs that were consistent with the GALL Report, Revision 2.

The licensee indicated that (1) periodic assessments of license renewal commitments and AMPs will be performed at least every three years; and that (2) the license renewal manager periodically reviews completed preventive maintenance activities that are credited for license renewal to identify potential aging effects.

The licensee changed one of the license renewal commitments in accordance with Section 50.59 of Title 10 of the Code of *Federal Regulations* (10 CFR) to eliminate inspections for specific components fabricated of corrosion-resistant materials.

The brief overview and summary of the audit and information gathered as mentioned above was prepared to transmit to the licensee in March 2014 (NRC ADAMS Accession Number:
ML 14017A289).

5.2 AMPs for Mechanical Systems

5.2.1 ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD (XI.M1)

5.2.1.1 Objective and Scope of the AMP

During the audit, the licensee stated that the RNP AMP is consistent with GALL AMP XI.M01, with no deviation. RNP entered the fifth 10-year Inservice Inspection (ISI) program interval on July 21, 2012. The ASME Section XI Code applicable to the fifth 10-year interval is the 2007 Edition through the 2008 Addenda. The licensee also noted that RNP is evaluating a possible modification of the actual inspection sub-intervals during the PEO, within the ASME Code allowable timing, to better align with RNP refueling outage schedule, including related considerations for the pressure tests.

The NRC staff asked the licensee if the RNP ISI program implementation has included any risk-informed inspection basis, or has any plans to do so. The licensee stated that the RNP ISI program has not used any risk-informed information and it has no currently planned action to do so.

The NRC staff also inquired about changes or updates to the RNP ISI program related to its nickel-base components. The licensee indicated that RNP replaced ultrasonic testing (UT) with the phased-array as the technique used for the reactor vessel loop pipe inspection. The licensee identified some weld indications during the inspection. However, the indications were all embedded (not inside diameter-connected or surface breaking) indications.

The NRC staff discussed with the licensee the inspections of socket welded locations, and whether any improvements or developments for use of UT in these cases were completed at RNP. The licensee noted that while no UT related work on socket welds had been completed, RNP will continue to follow the industry developments in related enhancements. The licensee also stated that its inspection program for socket welds is staggered with adequate coverage of these locations through the ISI program interval, but with essentially random selection. The NRC staff suggested that the ISI program would probably benefit if the sample selection included considerations of susceptibility and the significance of socket weld locations.

5.2.1.2 Effectiveness of the AMP to Meet its Objective

5.2.1.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The AMP is credited for aging management of selected components in several systems at RNP. The aging effects/mechanisms of concern listed in the RNP LRA are: (a) Cracking due to SCC, (b) Loss of Pre-load due to Stress Relaxation and Irradiation Creep, (c) Loss of Material due to Wear,

Aggressive Chemical Attack, Crevice Corrosion, General Corrosion, and Pitting Corrosion, and (d) Reduction of Fracture Toughness due to Thermal Embrittlement.

The RNP ISI program also ensures early detection of cracking due to thermal fatigue in the pressurizer surge line through the routine performance of volumetric examination of the surge line welds as stated in the Thermal Fatigue TLAA.

5.2.1.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The ISI AMP is continually upgraded based on the industry experience and related research. Actions are taken under RNP's Corrective Actions Program (CAP) to initiate the ISI AMP improvements.

5.2.1.3 Recommendations for Subsequent License Renewal

5.2.1.3.1 Good Practices or Strengths of the AMP

RNP noted that its Fifth Ten-Year Interval is based on the requirements of 2007 Edition with 2008 Addenda of the Code, and it includes requests for relief from ASME Code requirements, as described in ADAMS ML12082A009. RNP also noted that it is evaluating a possible modification of the actual inspection sub-intervals during the PEO, within the Code allowable timing, to better match (or align with) its outage schedule, including related considerations for the pressure tests. This would appear to be unique at this time to RNP.

5.2.1.3.2 Areas of the AMP for Further Consideration/Enhancements

Program Description:

No further review item identified.

1. Scope of Program:

In the evaluation of the ASME Section XI, Subsection IWB, IWC and IWD Program against the program elements of the GALL Report, exceptions to Code requirements that have been granted by approved relief requests were not considered exceptions to the GALL criteria. [SER, NUREG-1785]: One of the license conditions required that the future inspection activities identified in RNP (updated) UFSAR Supplement be completed prior to the PEO. According to the relief request, RR-23, (ADAMS ML110330085), RNP is considering an alternative to the requirement of IWB-2412, Inspection Program B, that volumetric examination of essentially 100% of reactor vessel pressure retaining, Examination Category B-A and B-D welds, be performed once each ten-year interval.

The alternative is for the interval to be 20 years (i.e., no inspection for the 4th ISI inspection, and only one, around 2021, during the PEO). The RNP "Fifth Ten-Year Interval Inservice Inspection Program" is based on the requirements of the ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, 2007 Edition with 2008 Addenda. It includes requests for relief from ASME Code requirements, as described in ADAMS ML12082A009. The status and adequacy of these new plan changes and relief requests to be operative in the PEO need confirmation.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

Ensure that the AMP includes the high strength closure bolts, regardless of code classification, as part of volumetric examination in accordance with the ASME Code Section XI, Table IWB-2500-1, Examination Category B-G-1.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. <u>Operating Experience</u>:

The ISI AMP is continually upgraded based on the industry experience and related research. Actions are taken under RNP's CAP to initiate the ISI AMP improvements.

5.2.2 Water Chemistry (XI.M2)

5.2.2.1 Objective and Scope of the AMP

The RNP AMP B.2.2 an existing program that is credited for mitigating the aging effects of loss of material due to erosion, fretting, crevice corrosion, general corrosion, galvanic corrosion, and pitting corrosion, as well as cracking due to SCC and IASCC and loss of heat transfer effectiveness due to fouling of heat transfer surfaces. These aging effects are mitigated by controlling the chemical species that cause the underlying aging mechanisms. Station chemistry procedures specify sampling scope, acceptance criteria, frequency, and corrective actions for sample results not within acceptance criteria. The efficacy of the RNP Water Chemistry Program is verified through its One-Time Inspection Program B.4.4.

5.2.2.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.2.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. RNP Water Chemistry Program B.2.2 was developed and implemented to meet industry guidance based on the Electric Power Research Institute (EPRI) primary and secondary water chemistry guidelines then in effect and cited in GALL Rev. 0. Since that time, RNP has continued to modify it program to conform to updated EPRI guidance as it is published and endorsed by the NRC. This is in conformance with the GALL Rev. 2 guidance on use of later editions/revisions of various industry documents. In addition, the RNP program includes an aging mechanism not identified in GALL Rev. 0, namely loss of heat transfer effectiveness due to fouling of heat transfer surfaces. This aging mechanism is included in the GALL Rev. 2 Water Chemistry AMP.

One good practice or strength of the AMP was identified in this review. The licensee stated that the water chemistry monitoring program undergoes continuing revisions and has been revised numerous times since license renewal in 2004. The Water Chemistry program maintains a Chemistry Data Management System, which is an electronic database used for storing, limit checking, reporting, and trending chemistry analyses. Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.2.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M2 Program Priority for Future Audits: The Water Chemistry Program continues to be critical to the management of significant aging mechanisms in the primary and secondary systems, and industry guidance is periodically updated. Therefore, this AMP is rated a High priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, because despite our requests, the audit team did not have access at this plant to the CR database Passport/Portal J. This made a thorough evaluation of the effectiveness and implementation much more difficult than at earlier AMP effectiveness audits at Ginna and NMP-1.

5.2.2.3 Recommendations for Subsequent License Renewal

5.2.2.3.1 Good Practices or Strengths of the AMP

M2.S-1: *Recommendation*: This activity performed under the licensee's monitoring and trending activities is considered a good practice or strength for effective implementation of the program.
***Technical Basis*:** RNP Operating Manual states that the plant maintains a Chemistry Data Management System (CDM), which is an electronic database used for storing, limit checking, reporting, and trending chemistry analyses.

5.2.2.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

M2.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The Water Chemistry Program continues to be critical to the management of significant aging mechanisms in the primary and secondary systems, and industry guidance is periodically updated.

1. <u>Scope of Program</u>:

The RNP Water Chemistry Program differs from GALL Rev. 0 AMP XI.M2, Water Chemistry, in the following two areas:

- An aging mechanism identified in the RNP AMR was not identified in the GALL Rev. 0 (Loss of Heat Transfer Effectiveness due to Fouling of Heat Transfer Surfaces). As noted above, this aging mechanism is included in the GALL Rev. 2 Water Chemistry AMP.

- The RNP Water Chemistry Program implements later revisions of the EPRI guidelines for Primary and Secondary Water Chemistry than recommended in GALL Rev. 0. The RNP Water Chemistry Program is based on the current, approved revisions of EPRI Guidelines as prescribed by NEI 97-06. This is consistent with the GALL Rev. 2 guidance on use of later editions/revisions of various industry documents.

During the audit, RNP stated that it presently follows the most recent EPRI water chemistry guidance, namely Rev. 6 (EPRI 1014986, dated 2007) for primary water and, Rev. 7 (EPRI 1016555, dated 2009) for secondary water. The auditors noted that a revision of the guidance for primary water chemistry is currently being prepared by EPRI and is to be published in the fall of 2013. RNP stated this updated guidance would be incorporated into their program within six months after approval by the NRC, though this timing could be extended somewhat by an intervening refueling outage.

Because the RNP Water Chemistry Program is periodically updated to conform to the most recent EPRI guidance and includes loss of heat transfer effectiveness due to fouling of heat transfer surfaces, it appears to be consistent with the GALL Rev. 2 AMP XI.M2.

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

RNP maintains a hydrogen concentration in the primary system in accordance with EPRI primary water chemistry guidelines to control the corrosive attack of components in contact with the primary coolant, and the H/O molar ratio is monitored. RNP also stated that they plan to implement Zn additions to the primary system starting two outages in the future (around 2016) to control background radiation levels.

In addition, RNP plans to make changes to the primary water pH specifications in the fall of 2015 as a part of the Zn additions program. These changes entail going from the present “modified pH” regime as described in the EPRI primary water chemistry guidelines to a “coordinated pH” or constant elevated pH program. RNP currently utilizes a regime with a minimum pH of 6.9 and a maximum pH of 7.4, with maximum lithium (as LiOH) level of 3.5 ppm and 2.2 ppm in the modified range. The proposed coordinated pH program maintains an elevated constant pH 7.1 with maximum lithium of 4.5 ppm for up to four effective full-power days (EFPD), followed by a maximum target of 3.5 ppm lithium to establish and maintain a constant pH of 7.1 for the remainder of the cycle. The principal purpose of these changes is to limit corrosion and activation product formation in the primary water system.

The RNP 2011 Secondary Chemistry Self Assessment noted several deficiencies in the plant procedures where the procedure requirements were not in agreement with the plant guidelines or where plant guideline requirements were not fully implemented in

the procedures. In addition, there were also several potential enhancements noted in these same procedures, which would clarify and better define the requirements of the EPRI Guidelines. Finally, there were several potential enhancements to be considered for inclusion into the procedures. However, the self-assessment noted that all control parameters were present in the Water Chemistry Program documentation, as required by the EPRI Guidelines.

During the audit, RNP personnel stated that all of these findings were characterized as “minor” deficiencies, and all were being actively addressed. They noted that their Water Chemistry Program undergoes frequent updates. In addition, significant analytical chemistry equipment has been added during the past 5-7 years. RNP agreed to provide the page 2 “Summary of Revisions” from the most recent 6 to 8 revisions to provide an indication of the sort of changes that are being made. Several other documents related to primary and secondary water chemistry were also made available.

In June 2012, RNP did a quick-hit self-assessment as an extension of condition corrective action activities to review the implementation of Primary Chemistry Guidelines due to the above issues identified with implementation of Secondary Chemistry Guidelines. Differences were identified between the requirements of the EPRI Guidelines and the requirements in RNP Chemistry procedures. In all cases, the requirements in RNP Chemistry procedures were more restrictive and more conservative than the EPRI requirements.

4. Detection of Aging Effects:

In RAI B.2.2-3 of the RNP SER (NUREG-1785), Section 3.0.3.3, the staff asked the applicant to provide the criteria that were used to select which piping will be evaluated to confirm the effectiveness of the Water Chemistry Program. In its response to RAI B.2.2-3, the applicant stated that a one-time inspection would be performed on selected components at susceptible locations covered under the Water Chemistry Program. Inspections will include internal visual or volumetric examinations to determine if loss of material or cracking has occurred. The results of these inspections will be used to assess the condition of the components in question and reviewed against assumptions made regarding the effectiveness of water chemistry controls in support of license renewal. Acceptance criteria will be based on construction code, manufacturers’ recommendations, engineering evaluation, or metallurgical examination, as appropriate. The staff found this response to be acceptable.

During the audit interview, RNP confirmed that this one-time inspection was performed and stated that it resulted in no significant findings. Specifically, 21 inspections of steam and power conversion systems protected by the Water Chemistry Program were performed in 2004 during refueling outage RO-22, and an additional 12 inspections were completed during RO-26 in 2010. The inspection locations were selected based on material and environments that would represent leading indicators of age-related degradation.

M2.4-1: *Recommendation*: A one-time inspection program that samples the entire system should be considered prior to entering the PEO to verify the continued effectiveness of the EPRI water chemistry guidance in controlling corrosion, SCC, and fouling before extending operating periods beyond 60 years. The scope and extent of this inspection program should be based in large part on the

plant-specific OpE with respect to corrosion, SCC, and fouling in the systems and components managed by this AMP. Additional periodic inspections may also be required if problems related to water chemistry develop during the PEO.
***Technical Basis*:** The EPRI and BWRVIP guidelines cited by GALL continue to provide the best available guidance on water chemistry control, but no OpE is available to verify their continued effectiveness for operating periods out to and beyond 60 years.

5. Monitoring and Trending:

As noted above, the RNP Operating Manual states that the plant maintains a Chemistry Data Management System (CDM), which is an electronic database used for storing, limit checking, reporting, and trending chemistry analyses. This is cited as a good practice. As an example of the use of this CDM data base, subsequent to the audit RNP provided CDM the output "Feedwater Iron and Copper: Integrated Results from 2000-2012 as Function of % Power" in response to auditor questions about the effects of the power uprates in 1979 and 2002 on water chemistry and iron transport in particular (see Operating Experience below).

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

RNP OpE with respect to water chemistry control for the period 1989 through 1999 is described in RNP Aging Management Program, Water Chemistry Program, Rev. 11, Section 6.3. A total of 82 condition reports were found, most of which dealt with excursions in chemical species exceeding applicable guidelines. No significant events were cited, and an independent search of LERs from 1980 through 2012 also found no significant events related to primary and secondary water chemistry.

RNP implemented power uprates in 1979 and 2002, and, during the audit, RNP was asked about the effects of these power uprates on water chemistry and on iron transport in particular. The 1979 uprate predated the experience of the RNP audit participants, but they stated that the 2002 uprate was accompanied by a reduction in iron transport in the secondary system and provided auditors documentation from the CDM. This was subsequently verified by data from the RNP CDM on "Feedwater Iron and Copper: Integrated Results from 2000-2012 as Function of % Power."

As reported in the SER Appendix A (Commitment Listing), Commitment Item 5 stated that the existing Water Chemistry Program is credited for aging management without any additional changes. The NRC IP-71003 inspections conducted in 2012 reviewed current procedures implementing the Water Chemistry Program and verified that they contained adequate information to meet this license renewal commitment. As part of the audit at RNP in January 2013, the staff reviewed the SER commitment #5 closure documentation binder and confirmed completeness of information, except for sections on OpE.

M2.10-1: ***Recommendation*****:** For any plants that have undergone a power uprate prior to LTO, the OpE subsequent to that uprate should be reviewed to verify stable GALL-compliant water chemistry prior to entering into LTO.
Technical Basis**:** RNP implemented power uprates in 1979 and 2002, and the latter uprate was found to result in a slight reduction in iron transport in the secondary system. This is in contrast to experience at Ginna, where an increase in iron transport after a power uprate was observed. At present, at most plants, only limited OpE (a few operating cycles) is generally available with respect to the possible effects of power uprates on water chemistry control.

5.2.3 Reactor Head Closure Stud Bolting (XI.M3)

5.2.3.1 Objective and Scope of the AMP

The RNP Reactor Head Closure Studs Program, B.2.3, is implemented through the ASME Section XI, Inservice Inspection, Subsections IWB, IWC, and IWD Program, which monitors the condition of the closure studs and stud components. It is implemented and maintained in accordance with the general requirements for engineering programs. The program is used to manage loss of material due to wear and loss of preload due to stress relaxation in reactor vessel head closure studs. In addition, Commitment Item 6 specified that the existing AMP B.2.3 would also provide monitoring and preventive activities to manage stud cracking.

While this AMP is not committed to the implementation of the RG 1.65, October 1973, head closure stud fabrication details and preventive measures are consistent with the recommendations of this regulatory guide. The RNP studs are A-540 B23 or B24, non-plated, annealed and heat treated to achieve an ultimate tensile strength of 931- 1,138 MPa (135-165 ksi). The studs are lubricated by Fel-Pro N5000 or an equivalent lubricant to inhibit corrosion.

The RNP program B.2.3 is consistent with GALL Rev. 0 AMP XI.M3 “Reactor Head Closure Studs” program.

5.2.3.2 Effectiveness of the AMP to Meet its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.3.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

(a) Include a technical basis for deleting coolant leakage as an aging effect managed by the GALL XI.M3 program.

5.2.3.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Revise the scope of program element to include clear guidance for plants that have SCC susceptible materials (i.e., yield strength exceeds 1,034 MPa or 150 ksi).

5.2.3.3 Recommendations for Subsequent License Renewal

5.2.3.3.1 Good Practices or Strengths of the AMP

The NRC staff noted that the licensee's recent UT examination results for the reactor vessel head studs were satisfactory without a relevant condition identified. The NRC staff also noted that the RNP ISI program summary report (ADAMS Accession No. ML12184A040) dated June 15, 2012, confirms that the licensee conducted visual and volumetric examinations of the reactor vessel head closure bolting components in accordance with the ASME Code Section XI, Table IWB-2500-1, Examination Category B-G-1 during refueling outage 27. The ISI summary report stated that no indication of aging was revealed by RNP's visual and volumetric examinations. The licensee further clarified that the ISI did not reveal any leakage or stress corrosion cracking of the reactor vessel head stud assemblies.

5.2.3.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M3.0-1: *Recommendation*: Revise the program description (or scope of program) to include a technical basis for deleting coolant leakage as an aging effect managed by the GALL XI.M3 program.
***Technical Basis*:** In all three versions of the GALL Report, AMP XI.M3 includes (a) inservice inspection (ISI) in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Subsection IWB, Table IWB 2500-1. The scope of program states that ISI is used to detect crack initiation and growth due to SCC or IGSCC; loss of material due to wear; and coolant leakage from reactor vessel closure stud bolting for both BWRs and PWRs in Rev. 0 and Rev. 1 of the GALL report. However, the scope of program in Rev. 2 of the GALL Report does not include coolant leakage (due to loss of preload caused by stress relation). It is not clear why this aging effect was dropped from this program. As a potential further review item, it is recommended to confirm and document whether the industry OpE indicates occurrences of loss of preload in the reactor vessel head closure assemblies during reactor power operation.

1. Scope of Program:

M3.1-1: *Recommendation*: Revise the scope of program element to include clear guidance for plants that have SCC susceptible materials (i.e., yield strength exceeds 1,034 MPa or 150 ksi).
***Technical Basis*:** The RNP program basis document states that to mitigate SCC, the reactor head closure stud material A-540 B23 or B24, was annealed and heat-treated to achieve an ultimate tensile strength of 931- 1,138 MPa (135-165 ksi). These values are consistent with the GALL, Rev. 0 AMP, which recommends the maximum tensile strength of the studs be limited to 1,172 MPa (170 ksi) (RG 1.65). However, the GALL Rev. 2, AMP provides a more conservative guidance and recommends using bolting material for closure studs that has an actual measured yield strength less than 1,034 MPa (150 ksi).

Some heats or product lots of the closure studs bolting material are likely to exceed the yield strength limit, although they may or may not meet the maximum tensile strength limit of 170 ksi and, therefore, would be considered susceptible to SCC. It would be helpful to revise the scope of program description to include specific guidance for reactor head closure studs that do not meet the yield strength maximum limit of 1,034 (150 ksi).

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.4 Boric Acid Corrosion (XI.M10)

5.2.4.1 Objective and Scope of the AMP

The RNP AMP B.3.2 “Boric Acid Corrosion” is an existing program that is credited with managing the aging of systems and structures exposed to borated water. The program was initially developed and implemented to meet GL 88-05 “Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants,” and to monitor the condition of the RCS pressure boundary components for boric acid leakage. The RNP AMP B.3.2 with the enhancements is consistent with the GALL Rev. 0, AMP XI.M10. It consists of (a) visual inspections of external surfaces potentially exposed to borated water leakage, (b) timely discovery of leak path and removal of boric acid residues, (c) assessment of the damage, and (d) follow-up inspections for adequacy of corrective actions. The aging effects/mechanisms of concern include (i) loss of material due to aggressive chemical attack and general, crevice, and pitting corrosion, and (ii) loss of mechanical closure integrity due to loss of material from aggressive chemical attack.

Several characteristics of identified leaks are reviewed to evaluate the significance and timing of repairs:

- Leak rate
- If the leakage is dripping or spraying on SSCs in the area of the leak
- The material on which the leakage is contacting
- The impact on safety, housekeeping, Operations, system performance

5.2.4.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.4.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The RNP Boric Acid Corrosion Control Program B.3.2 was initially developed and implemented to meet GL 88-05, and to monitor the condition of the RCS pressure boundary components for boric acid leakage. The program identifies components that are susceptible to corrosion from boric acid leakage and provides for visual inspection of adjacent components.” The program will be consistent with GALL Rev. 2, AMP XI.M10 when the following enhancements are made to the existing program, (a) ensure that mechanical, electrical and structural components in scope for license renewal are covered, and (b) identify other areas in which components may be susceptible to boric acid exposure (e.g., containment, auxiliary, and spent fuel buildings).

One good practice or strength of the AMP was identified in this review. The use of a fluid leakage management program for borated systems to evaluate leakage severity and risk of locations that are exposed to leakage is considered a good practice or strength of the AMP. Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.4.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M10 Program Priority for Future Audits: The Boric Acid Corrosion Control Program appears to be a mature industry program that was initially implemented in response to GL 88-05, and has further improved to address issues identified in Bulletins 2001-01 and 2002-02. Therefore, this AMP would be rated a "Low" priority for future AMP audits.

(b) The impact of design modifications on the frequency of leakage and Maintenance staff training program may need to be updated to address the repeated incidents of leakage.

5.2.4.3 Recommendations for Subsequent License Renewal

5.2.4.3.1 Good Practices or Strengths of the AMP

M10.S-1: *Recommendation*: This activity performed under the licensee's corrective actions is considered a good practice or strength for effective implementation of the program.
***Technical Basis*:** The licensee's program incorporates a "fluid leakage management program" for borated systems that looks at leakage severity and considers the "risk" of locations that have been exposed to leakage. Locations with high risk are generally repaired immediately, whereas low risk locations may be combined into a single CR for remediation.

5.2.4.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

M10.0-1: *Recommendation*: This AMP would be rated a Low priority for future AMP audits.
***Technical Basis*:** The Boric Acid Corrosion Control Program appears to be a mature industry program that was initially implemented as a result of GL 88-05, and which has been improved upon as a result of Bulletins 2001-01 and 2002-02.

1. <u>Scope of Program</u>:

The RNP program will be consistent with the GALL Rev. 2 AMP XI.M10 when the following enhancements are made to the existing program, (a) ensure that mechanical, electrical and structural components in scope for license renewal are covered, and (b) identify other areas in which components may be susceptible to boric acid exposure.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M10.4-1: *Recommendation*: The impact of design modifications on the frequency of leakage and Maintenance staff training program may need to be updated to address the repeated incidents of leakage.
***Technical Basis*:** The program continues to find and correct boric acid leaks and resulting boron deposits with a constant number of CRs identified at each refueling outage. The number of active leaks, between 2009 and 2012, appears to fluctuate in a range of 8-15. In addition, there have been repeated findings of boric acid deposits on the Safety Injection Pump A, and the reactor cavity pool seal ring. The pump gasket is not scheduled for repair until RO29 in 2015, and a modification of the seal ring is planned 2013 fall outage. As a result, the program indicator has been Yellow for the last several outages. However, the RNP program manager attributes the majority of these leaks to maintenance practices and not to aging effects. He also indicated that the increase in valve packing leaks was due to design change recently put in place for the style of packing material used. The Maintenance-staff training program may need to be updated to address the repeated incidents of leakage.

5. <u>Monitoring and Trending</u>:

The program indicator has been “Yellow” for several refueling outages, including in the last health report. The licensee documented in condition reports that the boric acid leaks identified after each refueling outage resulted in the removal of boron deposits. The licensee indicated that the majority of the leaks are related to maintenance practices, rather than aging effects. A trend analysis performed by the licensee in 2011 concluded that approximately 82 percent of the leaks in the operating cycle were related to packing glands, body to bonnet flange connections, mechanical seals, and fittings. The licensee also indicated that the increase in valve packing leaks could be related to the style of packing material used and design changes recently implemented at RNP.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.5 Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWRs Only) (XI.M11B)

5.2.5.1 Objective and Scope of the AMP

The RNP AMP B.4.1 “Nickel-Alloy Nozzles and Penetrations” is an existing program that is credited for managing the aging effects of primary water stress corrosion cracking (PWSCC) in nickel-alloy nozzles and penetrations. The program consists of (a) PWSCC susceptibility assessment to identify susceptible components, (b) monitoring and control of reactor coolant water chemistry to mitigate PWSCC, and (c) inservice inspection (ISI) of reactor vessel head penetrations to monitor PWSCC and its effect on the intended function of the component. For susceptible penetrations and locations, the program includes an industry wide, integrated, long-term inspection program based on the industry responses to NRC GL 97-01. In addition, prior to the period of extended operation as part of its amended license renewal Commitment No. 31 (NUREG-1785), the RNP AMP B.4.1 program incorporated the following:

(1) Perform evaluation of indications under the ASME Section XI program.

(2) Perform corrective actions for augmented inspections to repair and replacement procedures equivalent to those requirements in ASME Section XI.

(3) Maintain involvement in industry initiatives (such as the Westinghouse Owners Group and the EPRI Materials Reliability Project) and will systematically assess for implementation applicable programmatic enhancements, that are agreed upon between the NRC and the nuclear power industry to monitor for, detect, evaluate, and correct cracking in the vessel head penetration (VHP) nozzles, specifically as the actions relate to ensuring the integrity of VHP nozzles in the RNP upper reactor vessel head during the extended period of operation.

(4) Submit for review and approval, its inspection plan for nickel-alloy nozzles and penetrations, as it will be implemented from the applicant’s participation in industry initiatives, prior to July 31, 2009.

The licensee’s license renewal Commitment No. 31 (NUREG-1785) was amended to reflect the requirements of the augmented inspections of NRC Order No. EA-03-009, Feb. 11, 2003. In its SER staff concluded that the RNP program B.4.1 with the enhancements is consistent with the program elements recommended by the GALL Rev. 0 AMP, XI.M11.

The NRC IP-71003 inspection in Feb. 2010, verified that the licensee implemented the commitment items related to the evaluation of indications, the corrective actions for augmented inspections, and continuous involvement in industry initiatives into the implementing procedures. The inspections also verified that the licensee had submitted the license renewal inspection plan for NRC review and approval.

Note that the GALL Rev. 0 (2001) AMP “Nickel-Alloy Nozzles and Penetrations” was superseded in 2005 by GALL Rev.1 AMP XI.M11A, “Nickel-Alloy Penetration Nozzles Welded to the Upper Reactor Vessel Closure Heads of Pressurized Water Reactors (PWRs only),” which in turn was superseded in 2010 by GALL Rev. 2 AMP XI.M11B, “Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWRs Only).”

5.2.5.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.5.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) The GALL Rev. 2 AMP X11B includes aging management of loss of material due to boric acid-induced corrosion. However, the program simply calls for the GALL AMP XI.M10 Boric Acid Corrosion to manage such effects. It is unclear why the management of (loss of material from) boric acid leakage is different from, and not covered under, the XI.M10 AMP, which specifically deals with this issue.

One good practice or strength of the AMP was identified in this review. The Boric Acid Corrosion AMP has been updated to be consistent with the recommendations and guidance of GALL Rev. 2 AMP IX.M11B. The ASME Code Cases N 770-1, N 722-1 and N 729-1 as well as the additional conditions identified in 10 CFR50.55a related to nickel-alloy examinations, frequency, extent of examination, etc. are being implemented under the current inspection interval and will continue to be implemented in future. Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.5.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Since the susceptibility of nickel-alloys to PWSCC is strongly dependent on the water chemistry, particularly the ECP of the environment and the impurity content, it would be prudent to use the monitoring and trending information from the licensee’s Water Chemistry program to evaluate its impact on the incidents of PWSCC of nickel-alloy nozzles and penetrations.

5.2.5.3 Recommendations for Subsequent License Renewal

5.2.5.3.1 Good Practices or Strengths of the AMP

M11B.S-1: *Recommendation*: Licensee's continued involvement in industry and systematic assessment of applicable programmatic enhancements that are agreed upon between the NRC and the nuclear power industry to update its AMP B.4.1 to be consistent with the most recent version of the GALL AMP IX.M11B is considered a good practice and strength of the AMP.
***Technical Basis*:** As part of their preparation for the NRC AMP Effectiveness Audit, RNP compiled input from AMP Owners to compare it with GALL Rev. 2 AMP "Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWRs Only)." The GALL Rev. 2 program XI.M11B recognizes the industry's report MRP-139, "Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline," for the inspection of dissimilar metal welds in the primary system. It also recognizes ASME Code Cases N 770-1 "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities," N 722-1 "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated With Alloy 600/82/182 Materials," and N 729-1 "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds," for nickel-alloy components.

During the audit, the RNP AMP owner stated that the ASME Code Cases N 770-1, N 722-1 and N 729-1 as well as the additional conditions identified in 10 CFR50.55a related to nickel-alloy examinations, frequency, extent of examination, etc. are being implemented under the current 10-year inspection interval and will continue to be implemented in future inspection intervals. Since RNP has updated its AMP B.4.1 to be consistent with the recommendations and guidance of GALL Rev. 2 AMP IX.M11B, there are no deltas; therefore, no additional recommendations are necessary.

5.2.5.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

M11B.0-2: *Recommendation*: The boric acid leakage management aspect should be covered under the XI.M10 AMP, or provide the need/clarification for it to be part of this AMP.
***Technical Basis*:** As mentioned in the Program Description, the GALL Rev. 0 AMP XI.M11 has been replaced in GALL Rev. 2 by XI.M11B program, which addresses the issue of cracking of Ni-alloy components as well as loss of material due to boric acid-induced corrosion in susceptible, safety-related components near Ni-alloy reactor coolant pressure boundary components. However, although the GALL AMP X11B includes aging management of loss of material due to boric acid-induced corrosion, the program simply calls for the Boric Acid Corrosion program XI.M10 to manage such effects. The RNP program is consistent with GALL Rev. 0 AMP XI.M11B, but it does not include aging management of loss of material due to boric acid-induced corrosion, which is managed

under its Boric Acid Corrosion program B.3.2. It is unclear why the management of (loss of material from) boric acid leakage is different from, and not covered under, the XI.M10 AMP "Boric Acid Corrosion," which specifically deals with this issue.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

M11B.2-1: ***Recommendation*:** Evaluate the potential of the use of the monitoring and trending information from the Water Chemistry program to evaluate its impact on the incidents of PWSCC of nickel-alloy nozzles and penetrations.
***Technical Basis*:** RNP maintains a hydrogen concentration in the primary system in accordance with EPRI primary water chemistry guidelines to control the corrosive attack of components in contact with the primary coolant, and the H/O molar ratio is monitored. RNP also stated that they plan to implement Zn additions to the primary system starting two outages in the future (around 2016) to control background radiation levels. They plan to make changes to the primary water pH specifications in the fall of 2015 as a part of the Zn additions program. Since the susceptibility of nickel-alloys to PWSCC is strongly dependent on the water chemistry, particularly the ECP of the environment and the impurity content, it would be prudent to use the monitoring and trending information from the licensee's Water Chemistry program to evaluate its impact on the incidents of PWSCC of nickel-alloy nozzles and penetrations.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

RNP continues to participate in industry initiatives, such as EPRI PWR Materials Reliability Program (MRP), related to nickel-alloy cracking issues, and the program basis document is periodically updated to summarize these results and licensee's assessment.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.6 Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS) (XI.M12)

5.2.6.1 Objective and Scope of AMP

The RNP program B.4.2 “Thermal Aging Embrittlement of CASS Program” manages the effects of loss of fracture toughness due to thermal embrittlement of CASS components. The program is applied to CASS components within Class 1 boundaries of the Reactor Coolant System and connected systems where operating temperatures exceed the threshold criteria of 482°F, [Note: no class 2 or 3 CASS components exceed threshold temperature criteria] and includes CASS valves, reactor coolant pump casings, and piping elbows / fittings in the primary loop. The balance of primary loop piping and branch piping is forged and not susceptible to thermal aging (RNP-L/LR-0621, Rev. 2). Program does not include reactor vessel internals CASS components, which are managed by the RNP PWR Vessel Internals Program B.4.3. The applicant also noted that RNP does not have any Nb-bearing CASS materials.

Program addresses loss of fracture toughness on the intended function of the component consistent with Grimes letter on thermal embrittlement (ADAMS ML003717179). For potentially susceptible materials, the program relies on examination and plant/component specific flaw tolerance evaluation. The RNP inspection program noted that all CASS components within Class 1 boundaries are initially considered susceptible to thermal aging embrittlement mechanism irrespective of material. The RNP program B.4.2 also stated that valves and pump casings are adequately covered by existing inspection requirements in Section XI of the ASME Code, including the alternative requirements of CC N-481. Consistent with NRC guidance, AMP B.4.2 does not include additional inspections of pump casings, valve bodies, or piping. Westinghouse report WCAP-15363 presents an evaluation that demonstrates the applicability of CC N-481 to RNP reactor coolant pump casings over the period of extended operation. In addition, Westinghouse report WCAP-15628 describes a leak-before-break (LBB) flaw evaluation that justifies eliminating large primary loop pipe rupture. Both these reports considered reduced fracture toughness of thermally aged CASS material for the period of license renewal.

5.2.6.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.6.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) Clarify whether the GALL AMP XI.M12 should specifically include a flaw tolerance evaluation similar to CC N-481, for Class 1 pump casings as a necessary element for managing thermal aging embrittlement of the CASS material.

Information on potential effects of plant modifications on this AMP were not identified during this audit.

5.2.6.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Clarify whether the flaw tolerance evaluation in accordance with CC N-481 should be performed using the fracture toughness of thermally aged CASS material or the thermally aged flux weld material.

(b) Specify that the LBB or CC N-481 evaluations should include a list of the chemical compositions, and the ferrite content calculated using the Hull's expressions, to verify that none of the CASS materials contain more than 25 percent ferrite.

(c) Clarify that the LBB or CC N-481 evaluations should include a list of the chemical compositions, and the ferrite content calculated using the Hull's expressions, to verify that none of the CASS materials contain more than 25 percent ferrite.

5.2.6.3 Recommendations for Subsequent License Renewal

5.2.6.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.6.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M12.0-1: *Recommendation*: Revise the program description to clarify whether the GALL AMP XI.M12 should specifically include a flaw tolerance evaluation similar to CC N-481, for Class 1 pump casings as a necessary element for managing thermal aging embrittlement of the CASS material.
***Technical Basis*:** The GALL AMP XI.M12 states that for pump casings and valve bodies, screening for susceptibility to thermal aging embrittlement is not required. The existing ASME Section XI inspection requirements, including the alternative requirements of ASME CC N-481 for pump casings, are adequate for all pump casings and valve bodies. However, in the 2000 addenda of the ASME Section XI, Examination Category B-L-1 was revised to require VT-1 examination rather than volumetric examination of the pump casing welds and, subsequently, in 2004, ASME CC N-481 was annulled with the rationale that the code requirements

(including VT-1 examination of the pump casing welds) specified in the Code Case were incorporated into the ASME Code Section XI. In addition, the inspectability of CASS components using UT is also important for this AMP. Therefore, further review is recommended to determine whether the GALL AMP XI.M12 should specifically include a flaw tolerance evaluation (i.e., CC N-481) for Class 1 pump casings as a necessary element for managing thermal aging embrittlement of the CASS material.

1. <u>Scope of Program</u>:

M12.1-1: *Recommendation*: Revise the scope of program to specify whether the flaw tolerance evaluation in accordance with CC N-481 should be performed using the fracture toughness of thermally aged CASS material or the thermally aged flux weld material.
***Technical Basis*:** Consistent with NRC guidance in the GALL report, RNP AMP B.4.2 does not include additional inspections of pump casings because the evaluation in WCAP-15363 demonstrates the applicability of CC N-481 to RNP reactor coolant pump casings over the period of extended operation. The licensee confirmed that the flaw tolerance evaluation in WCAP-15363 was performed using reduced fracture toughness of thermally aged CASS material. The GALL AMP recommends that the bounding minimum fracture toughness of thermally aged CASS material containing less than 25% ferrite is similar to the fracture toughness proposed in the ASME Section XI IWB-3640 procedures for flux welds, disregarding the ASME Code restriction of 20% ferrite. Since the minimum saturation fracture toughness of the thermally aged CASS material is the same as that of unaged flux weld, the bounding flaw tolerance evaluation per CC N-481 should assume the fracture toughness of thermally aged flux weld material, which is expected to be 15 to 20% lower than that of the unaged weld.

2. <u>Preventive Action</u>:

Not applicable.

3. <u>Parameters Monitored/Inspected</u>:

The licensee performed flaw tolerance evaluations for the Class 1 CASS components to demonstrate flaw stability for the PEO as discussed in the RNP license renewal application. These flaw tolerance evaluations remain valid for the PEO and provide the basis for the CASS program. The licensee also continues to perform ISI as described in the ASME Code Section XI, Subsection IWB, IWC, and IWD consistent with 10 CFR 50.55a. The licensee also stated that no indication was detected in the Class 1 CASS components included in the scope of the CASS program

4. <u>Detection of Aging Effects</u>:

M12.4-1: *Recommendation*: Revise the detection of aging effects program element to clarify that the LBB or CC N-481 evaluations should include a list of the chemical compositions, and the ferrite content calculated using the Hull's expressions (Aubrey et al. 1982), to verify that none of the CASS materials contain more than 25 percent ferrite.
***Technical Basis*:** RNP states that the LBB evaluation in WCAP-15628 demonstrates large margin between detectable flaw size and

flaw instability. Therefore, an AMP to manage the effect of thermal aging embrittlement on primary loop piping and piping components is not required. However, the RNP LRA does not specify whether any of the RNP CASS material contained greater than 25 percent ferrite. If it did, then the guidance of GALL AMP regarding the minimum saturation fracture toughness of thermally aged CASS material is not applicable. However, during the audit, the RNP clarified that as described in WCAP-15363, Rev. 1, the ferrite content of Class 1 pump casing is less than 8 percent, and as described in WCAP-15628, the maximum ferrite content of the reactor coolant piping and piping components was 24.1 percent. Nonetheless, the detection of aging effects program element should be revised to clarify that such flaw tolerance evaluations of thermally aged CASS materials should include a list of the chemical compositions, and the ferrite content calculated using the Hull's expressions, to verify that none of the CASS materials contain more than 25 percent ferrite.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

M12.6-1: *Recommendation*: Revise the acceptance criteria to clarify the applicability of ASME Section XI, IWB-3500 or IWB-3640 procedures for thermally aged CASS materials.
***Technical Basis*:** The acceptance criteria program element states, "*Flaws detected in CASS components are evaluated in accordance with the applicable procedures of ASME Code, Section XI, IWB-3500 or ASME Code, Section XI, IWC-3500. Flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with ASME Code, Section XI, IWB-3640 procedures for SAWs, disregarding the ASME Code restriction of 20% ferrite*." However, it is not clear that the IWB-3500 guidance is not applicable to CASS materials that have been identified as "susceptible to thermal aging embrittlement" in accordance to the GALL screening criteria. Such CASS materials are evaluated according to IWB-3640 procedures for flux welds (per Article C-4210), provided the ferrite content of the CASS material is less than 25%. I assume that the guidance of IWB-3500 is applicable for either unaged CASS materials or CASS materials that are not "susceptible to thermal aging embrittlement." However, these CASS materials should meet the requirement for the specified minimum yield strength of 240 MPa (35 ksi) or less at 40°C (100°F), as specified in Tables IWB-3514-2 or IWB-3518-2).

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.7 PWR Vessel Internals (XI.M16A)

5.2.7.1 Objective and Scope of the AMP

NUREG-1785 dated March 31, 2004, described a commitment made by the licensee to submit a Reactor Vessel Internals Inspection Plan to the NRC for review and approval at least 24 months prior to implementation. On September 24, 2009, the licensee submitted the inspection plan WCAP-17077-NP, Rev. 0: "PWR Vessel Internals Program Plan for Aging Management of Reactors Internals at Robinson Nuclear Plant" (ADAMS Accession Nos. ML092720461 and ML092750338). Subsequently, on June 22, 2011, the NRC issued its final SER on MRP-227 "Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines" (ADAMS Accession No. ML111600498) as revised on December 16, 2011 (ADAMS Accession No. ML11308A770). The EPRI issued MRP-227-A in January 9, 2012 (ADAMS Accession No. ML12017A193).

On July 21, 2011, the NRC issued Regulatory Issue Summary 2011-07: "License Renewal Submittal Information for Pressurized Water Reactor Internals Aging Management," which stated that plants that have submitted their inspection plans could withdraw and submit updated plans, consistent with approved report MRP-227-A, no later than October 1, 2012. The licensee submitted its revised inspection plan WCAP-17077-NP, Rev. 1: "PWR Vessel Internals Program Plan for Aging Management of Reactors Internals at Robinson Nuclear Plant" (ADAMS Accession No. ML12278A399) on September 26, 2012.

5.2.7.2 Effectiveness of the AMP to Meet its Objective

This is a new program that is credited for managing the following aging degradation effects and the associated mechanisms on the intended function of the reactor internal components through inspection and condition monitoring activities in accordance with the augmented requirements defined under industry directives as contained in MRP-227-A and ASME Section XI: (a) Cracking due to SCC, IASCC, and fatigue; (b) loss of material due to wear; (c) reduced fracture toughness due to thermal aging embrittlement and irradiation embrittlement; (d) dimensional change and distortion and possible cracking due to void swelling, and (e) loss of preload due to thermal and irradiation-enhanced stress relaxation (or irradiation-enhanced creep), which may eventually cause subsequent degradation by fatigue and wear, and result in cracking. Where applicable, credit is taken for existing programs such as water chemistry, inspections in accordance with ASME Section XI ISI, thimble tube inspections, and mitigation activities

5.2.7.2.1 Adequacy of the Program Description

The RNP RVIs program fulfills the license renewal Commitment #33, which commits RNP to:

(a) *Participate in industry programs to investigate aging effects and determine the appropriate AMP activities to address baffle and former assembly issues, and to address changes in dimensions due to void swelling.*
(b) *Evaluate the results of completed research projects from the Westinghouse Owners Group (formerly WOG, now PWROG) and the EPRI MRP, and factor them into the PWR Vessel Internals Program as appropriate.*

(c) *Implement an augmented inspection during the license renewal term.*

5.2.7.2.2 Effectiveness and Implementation of the AMP

The licensee completed inspections of several internals components during the RNP spring 2012 refueling outage, including the control rod guide tube (CRGT) lower flange welds enhanced visual testing (EVT-1), the upper core barrel flange weld (EVT-1), the baffle-edge bolts visual testing (VT-3), the baffle-former assembly (VT-3) and the thermal shield flexures (VT-3), with additional inspections planned for the fall 2013 refueling outage. The licensee described accessibility issues with visual inspection of the CRGT lower flange welds. The licensee did not identify relevant indications in the areas inspected related to the CRGT lower flange welds, the upper core barrel flange weld, the baffle-edge bolts, the baffle-former assembly, and the thermal shield flexures. The licensee stated that they will replace their hold-down springs in an upcoming outage.

5.2.7.3 Recommendations for Subsequent License Renewal

5.2.7.3.1 Good Practices or Strengths of the AMP

RNP employs inspection and condition monitoring activities in accordance with the augmented requirements defined under industry directives as contained in MRP-227-A and ASME Section XI:
***Technical Basis*:** The During the audit, RNP described which RV internal components had been inspected under the augmented inspection plan. As part of the industry's effort, RNP inspected the guide tubes and the results were published in a WCAP report. Since the last inspection was under the last 10-year inspection plan, it was performed in accordance with WCAP-17077-NP Rev. 0, which required EVT-1 of welds and VT-3 of bolts. The results indicated acceptable wear (i.e., in single digits). However, RNP plans to re-inspect the guide tubes during the next outage, RO-28. Visual inspection of former and baffle bolts and thermal shield flexures, etc. was also performed; no significant indications were reported. RNP also stated that volumetric examination of baffle bolts was not performed during the last outage; it is planned during RO-28 in the fall of 2013. Westinghouse is scheduled to perform the UT inspections using the procedures based on the operating experience at Ginna; Westinghouse has used these procedures before in Dutch nuclear power plants. RNP also noted that the hold-down spring is scheduled for replacement in RO-29, with a hold-down spring constructed of a material that is not susceptible to degradation.

5.2.7.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

At the time when RNP AMP B.4.3 was developed and described in WCAP-17077-NP, the details regarding the augmented inspections, and the associated corrective actions for these inspections, had not been established. WCAP-17077-NP states that the EVT-1 specification augments the VT-1 requirements, to provide more rigorous inspection standards for SCC as demonstrated for

similar inspections in BWR internals. EVT-1 is also conducted in accordance with the requirements described for visual VT-1 examination with additional requirements (such as camera scanning speed) currently being developed by the industry.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

Since the RNP AMP relies entirely on the recommendations of industry initiatives as the basis for developing the inspection plan for RVIs, which may not be consistent with the staff's approach taken in certain AMRs in GALL, particularly RVIs that may be susceptible to void swelling or irradiation embrittlement (baffle bolts), it is important to ascertain how a plant has modified or updated the AMRs for RVIs.

4. Detection of Aging Effects:

WCAP-17077-NP states that any recommendation for EVT-1 inspection will require additional analysis to establish flaw-tolerance criteria, which must take into account potential embrittlement due to thermal aging or neutron irradiation. The industry, through the PWROG, has developed an approach in WCAP-17077-NP, which states that industry has developed an approach for acceptance criteria methodologies to support plant-specific augmented examinations. This work is summarized in WCAP-17096-NP, "Reactor Internals Acceptance Criteria Methodology and Data Requirements."

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.8 Flow-Accelerated Corrosion (XI.M17)

5.2.8.1 Objective and Scope of the AMP

The objective of this AMP is to manage the aging effect of wall-thinning due to the flow-accelerated corrosion (FAC) of components made of carbon steels as well as low-alloy steels, especially with low chromium content, in systems with single-phase (water) as well as two-phase (wet steam) flow. The aging mechanism of FAC refers to the result of interaction between the flow characteristics and the corrosion product influenced by the material composition and water chemistry. Any reference to the erosion (in erosion-corrosion) in the context of FAC is limited to the action of (non-impacting or non-abrasive) mechanical removal of material from the corrosion product (usually some form of an oxide film or layer) itself, and not directly from the base metal or original alloy material (underneath the corrosion product). That is, wall loss due to cavitation, impingement wear, or other similar mechanical effects is not addressed by this AMP.

The scope of this AMP covers piping elements, piping components, pressure boundary nozzles, safe-ends, vessel/shell walls, and some structural elements, of both safety-related and non-safety related systems within the primary pressure boundary as well as the balance-of-plant where FAC has been observed or is expected to occur.

For its effectiveness the FAC program relies on implementation of the EPRI guidelines: NSAC-202L-R2 or -R3. The program includes performing (a) an analysis to determine critical locations, (b) limited set of baseline inspections to determine the extent of wall thinning at these locations, (c) follow-up inspections to confirm the predictions, re-baseline the prediction model for observed thinning or any changes in the operating conditions, and (d) repair or replacement of components as necessary to meet the acceptance criteria for FAC. NSAC-202L-R2 or -R3 provides general guidelines for the FAC program. To provide reasonable assurance that all the aging effects caused by FAC are properly managed, the program includes the use of a predictive code, such as CHECWORKS, that uses the implementation guidance of NSAC-202L-R2 or R3 to satisfy the 10 CFR Part 50, Appendix B criteria for development of procedures and control of special processes.

RNP implements this program through its AMP B3.3 “Flow-Accelerated Corrosion Program” summarized in its LRA Section B.3.3 with the associated GALL AMP XI.M17 – Flow-Accelerated Corrosion (Rev. 0 of GALL Report, 2001). The RNP AMP B.3.3 states that it is consistent, with several enhancements, with the associated GALL AMP. Staff’s SER (NUREG-1785) confirmed the consistency of RNP AMP B.3.3 with the associated GALL AMP XI.M17 with enhancements. The LRA lists two enhancements: (1) include additional components potentially susceptible to FAC and/or erosion, and (2) specify corrective actions be taken in accordance with the CAP when certain acceptance criteria are not met. The staff reviewed the completion of these enhancements during the IP 71003, “Post Approval Site Inspection for License Renewal,” documented in RNP inspection reports. Additional enhancement prior to PEO related to its program concerning valves, for which RNP added a section to its implementing procedure that was specifically dedicated to valves and added a requirement to verify material alloy analysis for any potentially susceptible valves. The LRA notes that the AMP is in accordance with the EPRI guidelines NSAC-202L-R2 and utilizes the CHECWORKS predictive code.

5.2.8.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.8.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be generally adequate covering the related GALL AMP in latest Rev.2 of GALL Report (NUREG-1801).

Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.8.2.2 Effectiveness and Implementation of the AMP

During the audit, the NRC staff determined that the RNP recent (Third Quarter 2012) Program Health Report provided an adequate representation of the program's implementation and the status of current issues. The report noted that, based on UT results and trace chromium data collected in refueling outages 26 and 27, there is no wear taking place in the principal high energy systems. The licensee attributed the results to the extensive piping replacement with upgraded materials, major improvements in water chemistry since 1999, and the presence of trace chromium in plant piping.

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M17 Program Priority for Future Audits: The Flow-Accelerated Corrosion Program is in response to the NRC IE Bulletin 87-01, the NRC GL 89-08, and staff's report NUREG-1344. While the program implementation has reached a level of maturity its success depends on continued review and updating of the OpE. The continued instances of FAC related LERs, given the several piping replacements with FAC-resistant materials, are indicative of the program significance during LTO. Also, since the corrosion allowance in original design does not address FAC and the leak-before-break concept is generally not applicable to the FAC degradation, the combination of inspections and analysis upon which the program relies for its effectiveness needs to be demonstrably maintained over the LTO period. Therefore, this AMP is rated a "High" priority for future AMP audits.

Procedurally, RNP implementation of the XI.M17 AMP uses the EPRI guidelines of NSAC-202L-R2 and the industry code CHECWORKS for predictive analysis. RNP implements and maintains its FAC program in accordance with its general requirements for engineering programs which provides assurance that (i) the programs are effectively implemented to meet regulatory, process, and procedure requirements, including periodic reviews, (ii) qualified personnel are assigned as program managers, and are given authority and responsibility to implement the program, (iii) adequate resources are committed to program activities, and (iv) programs are managed in accordance with plant administrative controls revised to mandate that corrective actions are taken through RNP's CAP when certain acceptance criteria are not met. These attributes are considered to make the program and its implementation at RNP to be effective.

5.2.8.3 Recommendations for Subsequent License Renewal

5.2.8.3.1 Good Practices or Strengths of the AMP

M17.S-1: *Recommendation*: The RNP implementation of this AMP notes the following cautions and actions which the staff finds to be good practices that would be effective additions to the "Monitoring and Trending" element of the GALL Report AMP:

(a) The presence of chromium content (trace Cr > = 0.10%) should be a consideration with respect to inspection coverage within components and lines (for line correction factors) selected for grouped analysis of wear and for susceptible but not-modeled components.

(b) Carbon steel pipe and components should not be eliminated from FAC Program consideration or monitoring based solely on alloy analysis of the pipe sections. Follow-up inspections should be made to validate exclusions and documented in the susceptibility analysis.

(c) The program document should identify/list locations potentially susceptible to the "leading edge/entrance effect" where FAC resistant material is located immediately upstream of a carbon steel component in an FAC susceptible system, and the list should be maintained as replacements are made in the plant that introduce new/additional locations.

(d) The possibility for higher wear rate occurring within the previously noted area of degradation should be evaluated after repairs with external weld-overlay.

***Technical Basis*:** (a) Inspected components determined or known to contain > = 0.10% Cr may not accurately reflect the wear of similar non-inspected components with lower trace Cr. The material alloy section for analysis of components with measured wear data should be treated with careful consideration of this fact.

(b) Inspection results should corroborate the fact that no wear is occurring in order to form the basis for reduced FAC susceptibility. If replacing whole line segments with carbon steel material containing high trace Cr > 0.10%, or high trace Cr already exists, follow up inspections are warranted to confirm that there is no wear taking place, before making judgments on exclusion from the program, with proper documentation of the reasons.

(c) For components repaired by means of external weld overlay, non-linear (higher) wear kinetics can occur within the degraded area, as the damaged surface itself becomes a source of locally contributory turbulence and flow irregularities not present in the prior configuration.

5.2.8.3.2 Areas of the AMP for Further Consideration/Enhancements

Program Description:

M17.0-1: *Recommendation*: This AMP is rated as a High priority for future AMP audits.
***Technical Basis*:** The primary aim of this AMP is to address the potential for a direct in-service leakage or break in high energy steam or water systems, as the program was in response to such failures. FAC related failures have continued to occur including in recent years after increase in service life. The corrosion allowance in original design, as per the design codes, does not address FAC and for the type/form of damage due to FAC the leak-before-break concept cannot be generally relied upon. Also, the program relies on limited baseline and subsequent inspection locations, that is, if for any reason FAC remains undetected over a long period, it has the potential to lead to sudden and unexpected component failure and loss of functionality.

M17.0-2: *Recommendation*: Clarify the definition and intended usage of the term FAC for the aging degradation of wall-thinning addressed by this AMP, and exclude from the scope certain types of wall-thinning mechanisms often mixed or associated with the FAC. Include the materials, components, and systems to be managed for FAC under the scope of this AMP.
***Technical Basis*:** The term “wall-thinning” and, in some cases, “FAC” have been incorrectly identified with wall loss in general and/or that resulting from other types of degradation, e.g., erosion-corrosion, cavitation, impingement wear. Also, the management of FAC itself is significantly different between single-phase and two-phase flow systems, although both are addressed in this AMP, and the materials affected by FAC include not just general carbon steels but low-alloy steels, especially with low chromium content (where the chromium threshold is also dependent on single-phase versus two-phase flow).

1. Scope of Program:

M17.1-1: *Recommendation*: Include in the scope description the type of materials and components most likely to experience the FAC degradation to be managed by this AMP, and elements/focus of the program to incorporate a long-term strategy beyond the inspections. Include potential for FAC in low-alloy steels, especially for low-chromium and/or two-phase flow locations. Include as an element of focus within the scope for long-term operation the need for reducing future FAC wear rates.
***Technical Basis*:** The program scope should clarify or well characterize the extent of this AMP to note, as a minimum, that it includes general carbon steels as well as low-alloy steels, especially with low chromium content, as the materials, and piping elements, piping components, pressure boundary nozzles, safe-ends, vessel/shell walls, and some structural elements as components subject to the FAC. NSAC-202L-R2 and -R3 incorporate “Long-term Strategy” as an essential part of a plant FAC program scope. According to the EPRI guideline strategy the FAC program should focus on reducing FAC wear rates without which the number of needed inspections will increase with service time, and even with selective repair and replacement, the likelihood of a consequential leak or rupture may increase with service time.

2. <u>Preventive Action</u>:

M17.2-1: *Recommendation*: Emphasize the role of mitigative measures for the long-term operations and clarify limitations of the noted mitigation options as dependent on the single-phase versus two-phase flow conditions.
***Technical Basis*:** Effectiveness of chemistry control and material selection for FAC mitigation depends on whether the FAC is under single phase flow or two-phase flow. Although one of the objectives is to prevent failure of a component due to FAC, since the approach is based on inspection of a prioritized and limited sample of susceptible locations, such preventing of all FAC-related leaks and ruptures may not be possible, especially with the potential for susceptible locations to remain uninspected for longer term of operation. Therefore, the significance of aggressively adopting mitigative measures in the AMP needs to be emphasized for the program to be effective over an extended period of operation.

3. <u>Parameters Monitored/Inspected</u>:

No review item identified.

4. <u>Detection of Aging Effects</u>:

No review item identified.

5. <u>Monitoring and Trending</u>:

M17.5-1: *Recommendation*: Revise to clarify or reconcile the apparent contradiction in stating that “CHECWORKS is acceptable because it provides a bounding analysis for FAC” and that “CHECWORKS is not always conservative when compared to actual field measurements.” Recommend that the projection for wall thinning be based on a bounding estimate of the FAC rate allowing for uncertainty. Recommend an engineering evaluation and appropriate program adjustments for cases where the condition monitoring did not meet the expected (bounding) performance, and to document reasons or inadequacies (programmatic, operational, modeling, model inputs, etc.) for recalibration of projection basis.
***Technical Basis*:** For projection basis, it is the incremental wall-thinning (i.e., the FAC rate estimation going forward) which is a determining factor so that its value and associated uncertainty in this estimation need to be conservatively bounded and subsequently confirmed, rather than to impose any correction to the basis after the fact. That is, any benchmarking and use of bounding values should be based on a comparison of the predictions against conservative estimate of the observed wall-thinning rates. Also, for those components that were deemed not to require immediate repair or replacement, the inspection frequency is to be such that the repair or replacement occurs prior to reaching the wall thickness criteria. It implies that the condition monitoring aspect of the program is not met if the observed wall thickness during any inspection is below the allowable limit, in which case an engineering evaluation and self-assessment of the of monitoring and trending elements of the FAC program need to be performed and adjustments made such that the OpE is demonstrably bounded, and the root cause of failure to meet the expected performance has been identified and addressed in the program.

6. <u>Acceptance Criteria</u>:

M17.6-1: *Recommendation*: Provide some guidance and/or basis document on relevant acceptance criteria needed in assessing the aging effect due to FAC for reasonable assurance of its management. ***Technical Basis*:** The current program description and referenced basis document lack guidance on the acceptance criteria needed to assess and disposition the findings of wall-thinning due to FAC for reasonable assurance of its management. The acceptance criteria are needed to disposition the as-observed wall-thinning or the as-predicted minimum wall at the end of next inspection interval. This disposition about repair, replacement, and inspection interval is based on criteria which are independent of the NSAC-202L-R2 or -R3 and the prediction model such as CHECWORKS, and need to address (conservatively account for) applicable mode(s) of failure. CHECWORKS does not provide assurance for meeting ASME acceptance criteria (for allowable minimum wall) – as these are outside the scope of CHECWORKS. The ASME Code Case 597-2 provides requirements applicable to nonplanar flaws of the type resulting from FAC. These requirements are for Class-1, -2, and -3 piping elements, as given in Subsection-3220 "Acceptance" of the Code Case which are in addition to the acceptance standards of the Construction Code of record. This Code Case has received conditional acceptance by the NRC, i.e., alternative requirements must be supplemented in order to provide an acceptable level of quality and safety. The Code Case itself indicates in Subsection-3223 that the acceptance by engineering evaluation for Class 1 piping shall be conducted with methods and criteria developed by the Owner. The supplemental requirement for Class 1 piping not meeting the criteria by inspection is that the use of evaluation methods and criteria is subject to NRC review and approval per 10 CFR 50.55a(a)(3). Also, in Subsection-3500 "Wall Thickness Acceptance Standards" item (5)(b), the Code Case indicates that the acceptance criteria for Class-1, -2, and -3 pumps, valves, flanges, reducing elbows, socket and weld fittings, and any other piping items not covered by Subsection-3500(a) are the responsibility of the Owner.

M17.6-2: *Recommendation*: Review and include the needed guidance for acceptance criteria, independent of any predictive method, to be used to meet the applicable requirements (listed below).
***Technical Basis*:** The FAC relevant safety-related portions of various reactor coolant and balance-of-plant systems are required to meet seismic criteria, design quality assurance of 10 CFR 50 Appendix B, as well as the ISI and IST under 10 CFR 50.55a(q), ASME Code Section XI, in addition to the applicable Codes and Standards for the original design and fabrication. The quality assurance of 10 CFR 50 Appendix B requires that the acceptance criteria be verified with independent testing and/or theory and analysis. Also, over the extended period of operation if the seismic criteria or inputs to the seismic analysis are updated or if the transient definitions change then the basis for estimating allowable minimum wall thickness is likely to be affected; the acceptance criteria for FAC AMP should reflect this possibility.

7. <u>Corrective Actions</u>:

No review item identified.

8. <u>Confirmation Process</u>:

No review item identified.

9. <u>Administrative Controls</u>:

No review item identified.

10. <u>Operating Experience</u>:

M17.10-1: *Recommendation*: Include in the element description the need for a self-assessment and a critical review of plant-specific program to identify and correct reasons if long-term strategy of reducing FAC wear rate and frequency of occurrence is not meeting performance goals from the OpE.
***Technical Basis*:** The expectation from incorporation of improved methods and industry experience over a long period in the FAC management is that frequency and severity of FAC incidence will be reduced with time. According to the EPRI guideline strategy the FAC program should focus on reducing FAC wear rates without which the number of needed inspections will increase with service time, and even with selective repair and replacement, the likelihood of a consequential leak or rupture may increase with service time. This should be confirmed at the individual plant level through the program self-assessment.

5.2.9 Bolting Integrity (XI.M18)

5.2.9.1 Objective and Scope of the AMP

The objective of this program is to manage the aging-related degradation of closure bolting for pressure retaining components of safety-related as well as non-safety related systems, separately from the structural bolting. The aging effects managed by this program include loss of preload, loss of material (due to wear or corrosion), and cracking of the bolting.

The closure bolting addressed by this AMP includes components of the RCS, the RCPB and reactor internals. In addition, this AMP is also credited to manage the aging-related degradation of bolting in the engineered safety feature systems, the auxiliary systems, and the steam and power conversion systems. However, the reactor closure head stud bolting is managed under GALL AMP XI.M3. In addition, all structural bolting are addressed in other GALL AMPs: XI.S1, “ASME Section XI, Subsection IWE”; XI.S3, “ASME Section XI, Subsection IWF”; XI.S6, “Structures Monitoring”; XI.S7, “RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants”; and XI.M23, “Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems.” The GALL AMP XI.M1, ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD, which includes inspection of safety-related and non-safety-related closure bolting, supplements but does not replace or substitute for this bolting integrity program.

RNP LRA Section B.3.4 summarizes RNP’s implementation of the associated GALL AMP XI.M18 – Bolting Integrity (Rev. 0 of GALL Report, 2001). The RNP AMP B.3.4, as well as staff’s SER (NUREG-1785) note that the LRA AMP is consistent with the associated GALL Report AMP XI.M18, with exceptions to scope of program and inspection needs and requirements for monitoring cracking in high strength bolting of NSSS supports. Also, the RNP AMP B.3.4 has enhancements to its Preventive Actions element and its Parameters Monitored/Inspected element. Furthermore, the RNP Bolting Integrity AMP itself relies on other RNP AMPs which include ASME Section XI ISI Programs (Subsections IWB, IWC, and IWD), the Preventive Maintenance Program, Boric Acid Corrosion Program, and the System Monitoring Program.

The two enhancements, as noted in LRA section A.3.1.12 and in the staff’s LRA Inspection Report (NRC IR 2003009), are: (1) revise administrative controls for bolting to prohibit the use of molybdenum disulfide compound in high-strength bolting applications, and (2) inspect and evaluate the high-strength bolting used on one motor operated valve prior to PEO. Staff’s Post-approval Site Inspection for License Renewal Inspection Report (NRC IR 2010008) confirmed that RNP had completed the necessary actions on its related commitment prior to the start of PEO.

The two exceptions noted for this AMP in the RNP LRA are: (1) it does not address AMR for structural bolting, because these are accomplished under ASME Section XI, Subsection IWF, and the Structures Monitoring Program, which is consistent with the (current) Rev. 2 of GALL Report, and (2) high-strength bolting used in NSSS component supports will not be subjected to an ongoing program for crack monitoring, since the bolting has been evaluated by RNP to be not susceptible to stress corrosion cracking owing to its location in a benign environment.

5.2.9.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.9.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be generally adequate covering the related GALL AMP in latest Rev.2 of GALL Report (NUREG-1801).

Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.9.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M18 Program Priority for Future Audits: The Bolting Integrity AMP manages aging of closure bolting for pressure retaining components which provide a direct interface to the reactor coolant boundary and safety-related equipment as delineated in NUREG-1339. The program also includes preventive measures to preclude or minimize loss of preload and cracking instances due to aging effects on these bolting. While the industry experience is generally good with timely detection of these effects, the experience has shown the need for its continued management as well. Therefore, this AMP is rated a “High” priority for future AMP audits.

(b) Procedurally, RNP implementation of the XI.M18 AMP relies entirely on other RNP AMPs. While the program implementation at RNP appears to be generally effective, the trending of its CRs under this AMP and tracking the effectiveness of its implementation become difficult due to the scattered nature of its program that relies on its corrective actions program (CAP) and related varied maintenance activities through other AMPs.

5.2.9.3 Recommendations for Subsequent License Renewal

5.2.9.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.9.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M18.0-1: *Recommendation*: This AMP is rated as a High priority for future AMP audits.
***Technical Basis*:** Bolting Integrity AMP relies on effective maintenance practices and contains preventive elements to manage various aging effects on the leakage integrity of closure bolting for pressure retaining components and safety-related equipment. Therefore, timely action and periodic inspections and self-assessment are critical to maintain program effectiveness through the long term operation.

M18.0-2: *Recommendation*: Confirm and replace the EPRI basis documents for this AMP with the latest, consolidated guidance from EPRI, strongly recommending adherence to the uniform basis. Use of basis documents and/or AMPs not listed in the GALL bolting integrity AMP description will be an exception to XI.M18 requiring that the LRA clearly identify which basis documents are used under which credited AMPs and how these alternatives meet the bolting integrity program activities.
***Technical Basis*:** The practice of using AMP basis documents other than those listed in the GALL Report or those industry documents that have been updated since, has the potential for uncertainty about consistency and effectiveness of program implementation, especially if the documents used are much older (e.g., EPRI NP-5067 which has been replaced by EPRI 1015336) than the recommended basis. In addition, the industry-recommended guidance has changed as bolting practices and experience have evolved, so the various basis documents listed have remnant contradictions. The EPRI NMAC study has reconciled and consolidated the various earlier EPRI/industry guideline documents into two EPRI reports (1015336 and 1015337). If the AMP is not updated for changes in basis documents, especially as revised by the industry and the regulatory body, then uniformity of implementation, and confirming effectiveness of the AMP require additional and unnecessary effort.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

M18.2-1: *Recommendation*: The guidance on preventive actions should be limited to those specified in the recommended or updated basis documents listed in the XI.M18 program description. Incorporate specific guidance with regard to the level and monitoring for preload.
***Technical Basis*:** Incorporation of multiple or old guidelines for preload likely results in non-uniformity and conflicting requirements. Also, determination and monitoring of actual preload have been problematic and often substituted by torqueing specifications. For consistent and effective management of bolting performance a definitive guidance on the level and monitoring of the preload would be better in LTO.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

M18.4-1: *Recommendation*: The AMP should include identification of all in-scope high-strength bolting based on the actual yield strength and provide guidance for those cases where this identification is not possible or implemented.
***Technical Basis*:** While the recent Rev. 2 of GALL Report adds a statement clarifying the volumetric examination requirement for all high-strength closure bolting, this was unclear in previous versions of the GALL Report used as a basis in most existing plants. Program implementation cannot be as effective unless the high-strength bolting has been fully identified based on the actual yield strength. SCC degradation of the high-strength closure bolting has the potential to remain undetected or not necessarily lead to identifiable leaks during LTO which can contribute to the loss of functionality. Also, if a susceptible heat of material was used in multiple bolts whose high-strength attributes remained unidentified, then the likelihood of multiple failures can potentially reduce any effectiveness of the redundancy.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No review item identified.

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

M18.10-1: *Recommendation*: Include in the AMP guidance a periodic review of the program confirming the reduction of bolting related events and, depending on the review findings, recommend appropriate corrections or adjustments to the program, through better training, tools, or practices.
***Technical Basis*:** The OpE on bolting-related activity shows that the overall effectiveness of this AMP is quite plant-specific and is

considerably impacted by personnel training (qualification) and maintenance practices followed. Repeat instances of bolting-related reports or corrective actions are also indicative of a need for improvements and self-assessment of plant-specific implementation of this AMP. While these may not directly reflect on any aging effect, per se, the continued instances reflect on the quality and adequacy of the bolting procedures or implementation, since, for the program to be demonstrably effective over time, the evolution of the frequency and number of locations of identified leakages (at the bolting interfaces) should not be growing. This specific guidance or assessment would

M18.10-2: *Recommendation*: Include in the OpE section the RNP instance of boric acid wastage of bolting closure of reactor coolant pump (RCP) flange bolts, for assessing possible need to check and re-tension the closure bolts on a more frequent basis as a preventive action.
***Technical Basis*:** RNP noted an instance of boric acid wastage of bolting closure (studs and nuts) on one of its RCP main flange identified during a visual inspection. While the boric acid wastage effect may be covered under the Boric Acid Corrosion AMP the wastage is only a symptom subsequent to the bolting performance degradation caused by the stress relaxation over several operating cycles. This cause should be identifiable and managed with timely action under the bolting integrity AMP.

5.2.10 Steam Generators (XI.M19)

5.2.10.1 Objective and Scope of the AMP

The objective of XI.M19 Steam Generator Tube Integrity (SGTI) AMP is to manage the aging of SG tubes, plugs, sleeves, and secondary side components (SG internals) for the functioning of SGs as required under the applicable technical specifications. This AMP manages multiple forms of aging related degradation on the primary and secondary sides of the SGs. Thus, in addition to the PWSCC of SG tubes, sleeves, and plugs, the AMP manages wall thinning of tube-support structures susceptible to FAC and general corrosion (in the secondary side of SGs), cracking due to stress corrosion or other mechanisms and loss of material due to fretting or corrosion of various supports (secondary side internals), tube denting due to corrosion of carbon steel support plates at tube intersections, cracking due to SCC/IGA and loss of material from fretting/wear of tubes and sleeves (from the secondary side).

At RNP, the objective and scope of SGTI AMP are covered under its SGTI Program B.2.4. The original RNP AMP was developed and prepared in accordance with Rev.0 of GALL Report, 2001 with the prevailing industry guidance of NEI 97-06. The RNP AMP is periodically updated to meet these guidelines and it is performed under RNP's site-specific overall Steam Generator Program. The RNP SGTI AMP specifies inspection scope, frequency, and acceptance criteria for the plugging and repair of flawed SG tubes in accordance with the plant technical specifications and the guidance of NEI 97-06, and includes inspections of other SG components – tube plugs, tube support plates and anti-vibration bars. The RNP steam generator program includes loss of material due to crevice corrosion and pitting corrosion of the tube plugs, loss of material due to crevice corrosion, erosion, pitting corrosion and cracking due to SCC of the tube support plates. RNP's SGTI AMP B.2.4 is consistent with the associated GALL Rev. 0 AMP XI.M19.

The AMP XI.M19 relies on six aging management activities: (i) periodic degradation assessment of SGs, (ii) condition monitoring and operational assessment of SGs, including structural and leakage integrity of tubes to meet specific performance criteria, (iii) qualified periodic examinations/inspections for the listed (expected) forms of degradation, (iv) dispositioning of all flaws/indications with technically justified acceptance criteria for each form of degradation, (v) acceptable methods of tube plugging and repairs, and (vi) on-line leakage monitoring. This AMP also relies on monitoring and maintenance of (primary and secondary) water chemistry as described in GALL AMP XI.M2 (NUREG-1785).

5.2.10.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.10.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to adequately encompass varied aspects covered under the related GALL AMP in latest Rev. 2 of GALL Report (NUREG-1801).

One good practice or strength of the AMP was identified in this review. The program description included specific aging effects/mechanisms of concern for which the AMP activities were aimed, and noted more specifically items of some significance that the RNP SGTI program ensures, namely, it includes tube plugs, tube support plates and anti-vibration bars in the SGs and addresses loss of material due to crevice corrosion and pitting corrosion of the tube plugs, loss of material due to crevice corrosion, erosion, pitting corrosion and cracking due to SCC of the tube support plates.

Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.10.2.2 Effectiveness and Implementation of the AMP

During the audit, the licensee indicated that the recent plugging of the steam generator tubes was due to wear that resulted from interaction with the pieces of spiral wound gaskets. Specifically, RNP's System Health Report (December 3, 2012) indicates that a total of 18 tubes were plugged in refueling outages 24 and 26 and all tube damage was due to foreign material excursion (FME). The Program Health Report also indicates that the FME, which caused the tube wear, was determined to have originated from the degradation of the spiral wound gaskets on feedwater heaters 6A and 6B. The Program Health Report further indicated that the gaskets were replaced with a different style of gaskets to prevent release of gasket pieces into the secondary water system and a personnel performance issue is also being addressed with training. In addition, the Program Health Report stated that improvements will be assessed during the fall 2013 refueling outage 28.

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M19 Program Priority for Future Audits: The SGTI Program is based on mature technologies and industry-wide implementation that has demonstrated its effectiveness over some time. At the same time, the program is also subject to periodic guidance updates and is fairly wide in scope and significance, especially for ensuring timely detection of varied forms of aging degradation known to have affected multiple SG components relied upon for maintaining the integrity of this very large pressure boundary. Therefore, this AMP is rated a "High" priority for future AMP audits.

(b) Procedurally, RNP implementation of the XI.M19 AMP uses various programs and guidelines which include: RNP's Steam Generator Program, related sections of Technical Specifications, its SG Inspection and Eddy Current Analysis Guidelines, and its Corrective Actions Program for conditions exceeding the SGTI AMP acceptance criteria. Also, the program is continually upgraded based on industry experience and research, EPRI and NEI guidance and its self-assessment.

5.2.10.3 Recommendations for Subsequent License Renewal

5.2.10.3.1 Good Practices or Strengths of the AMP

M19.S-1: *Recommendation*: RNP performs periodic self-assessment of this AMP and its program health report for the overall health of its SGTI program which identify any deficiencies and recommendations for improving the program. RNP's latest health report suggested that foreign objects related damage to the SG tubes showed increased trend with time and the identified corrective actions included removing the sources of foreign objects from the secondary systems and improvements to the related foreign materials program; also, significant deposit build-up on tubesheet and upper-bundle were noted and corrective actions implemented. This type of periodic assessment is considered good practice, and a similar assessment may be considered for inclusion as a part of program element 10, Operating Experience.
***Technical Basis*:** The observations of RNP are generally applicable to the similar AMP implementations at other plants, and the sharing and active participation across the industry would enhance the utility and effectiveness of this AMP.

5.2.10.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M19.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The industry-wide application of SGTI Program over several decades has demonstrated that it has been effective in managing varied forms of degradation in SG tubes and SG internals. The program results have also shown and led to significant and periodic updates in inspection methods, data analysis and areas of coverage for this uniquely large pressure boundary. Therefore, this AMP is rated a "High" priority for future AMP audits.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. <u>Detection of Aging Effects</u>:

M19.4-1: *Recommendation*: Consider expanding the guidance on aging effects of secondary side SG components to include specific inspections for any replacements, AVB supports, steam dome area, tubesheet cladding, divider plate and associated weld locations, and related degradation assessment.
***Technical Basis*:** It is noted that the industry guidance is less specific for the secondary side inspections and degradation assessment, and that the latest EPRI guidance (EPRI 1022830, 1025133) requires utilities to develop and implement secondary side inspections and secondary side integrity assessments, including SG internals, such that the tube safety functions are not compromised by the secondary side internals degradation. Also, there is no well qualified eddy current inspection technique at present for various weld locations adding inspectability concerns to the associated potential PWSCC issue.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. <u>Acceptance Criteria</u>:

M19.6-1: *Recommendation*: There appear to be situations, as exemplified by the RNP's adoption, where temporary alternate repair criteria (ARC) and related inspection plan changes may be made permanent through plant-specific technical specification. In these cases the criteria element of the AMP should examine and confirm/address if the basis for these changes involved any time-limited assumptions.
***Technical Basis*:** The change from temporary (one or two operating cycle) ARC to permanent ARC can affect the frequency and scope of inspections (from prior to the ARC) and/or contribute to additional unaccounted operational leakage, both of which may impact the basis for meeting structural integrity performance criteria of the tubes or portions of tubes affected by the ARC. Further, if the basis for temporary ARC involved any time-limited analysis or assumptions then these would need to take into account any lengthened interval of the ARC application.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M19.10-1: *Recommendation*: The OpE and SG program assessment at RNP indicate the need for addressing more pro-actively the secondary side degradation effects of wear due to foreign objects either from maintenance or service, and of deposit build-up over time, either on the tubesheet or in the upper tube bundle. Active management of these contributing factors to the aging effects on tube integrity (from the secondary side) should be included as part of the SGTI AMP for the long term operation
***Technical Basis*:** RNP's Health Report on the SGTI Program suggested that the tube damage due to foreign objects led to an increased frequency of tube plugging with time. The related causes were identified to be pieces of gaskets from secondary systems and foreign material excursions. RNP also noted significant buildup of deposits within the SGs over time which can accelerate secondary side tube degradation mechanisms which is indicative of inadequate cleaning and/or secondary side chemistry supporting greater than desired rate of iron deposition within the SGs.

5.2.11 Open Cycle Cooling Water System (XI.M20)

5.2.11.1 Objective and Scope of the AMP

RNP implements this program through its Open-Cycle Cooling Water Program (AMP B.3.5), also identified at RNP as the "Cooling Water Reliability Program (GL 89-13)." The RNP LRA states that this program generally corresponds to GALL, Rev. 0, AMP XI.M20 ("Open Cycle Cooling Water System"). The program is credited for the managing the following aging effects in open-cycle cooling water system components: flow blockage and loss of heat transfer effectiveness due to fouling; loss of material due to general, crevice, galvanic, and pitting corrosion; MIC; and loss of material due to erosion.

As a result of license renewal review, an enhancement was made to initiate an action under the RNP Preventive Maintenance Program (B.3.18) to periodically replace cooling coils in certain room coolers. The old copper tubes were replaced with tubes fabricated of the austenitic alloy AL-6XN. In addition, a requirement to perform a one-time volumetric inspection of the CCW heat exchanger tubes prior to the end of the current license period was incorporated into the RNP One-Time Inspection Program (B.4.4). In addition to the above, the four containment air coolers, which had been replaced in 1990, are being inspected by EC on a rotating basis, with one inspection during each outage. With these enhancements, RNP states that its Open-Cycle Cooling Water Program is consistent with GALL AMP XI.M20.

5.2.11.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.11.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. RNP Open-Cycle Cooling Water System Program B.3.5 was developed based upon guidance provided in GL 89-13 and 10 CFR Part 50, Appendix B, with the enhancements noted above. The RNP LRA states that its AMP B.3.5 was the subject of an NRC Service Water Operational Performance Inspection soon after program development to verify implementation of the GL requirements. This resulted in an "Integrated Service Water Action Plan" to address several NRC open items. The open items have been resolved. The staff determined during the audit that the overall program meets the requirements of GALL Rev. 2 AMP XI.M20.

5.2.11.2.2 Effectiveness and Implementation of the AMP

During the audit, the NRC staff noted that the original admiralty brass tubing in the component cooling water heat exchanger had previously been replaced with 90/10 copper nickel tubing in 1990. This tubing material was proactively replaced with AL-6XN during refueling outages 25 and 26, since the old tubing still had acceptable wall thickness. However, an evaluation of the ongoing erosion and corrosion concluded that the heat exchanger tubing would not be acceptable through the end of the PEO. The licensee had also included the inspections of these heat exchangers as part of its One-Time Inspection Program (discussed below). Also during the audit, the staff discussed with the licensee whether coatings were applied in service water components. The licensee stated that most of the service water carbon steel heat exchanger surfaces have been coated with a polymer ceramic coating to control corrosion, and that no issues regarding degradation of these coatings had been identified. All safety related service water heat exchangers are inspected for degradation per GL89-13 and no issue with coated or uncoated surfaces have been identified.

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M20 Program Priority for Future Audits: The Open-Cycle Cooling Water System Program continues to be necessary to the management of aging effects in the open-cycle cooling water system. While these aging effects do not generally result in immediate safety concerns, they do potentially impact the long-term reliability of SSCs having safety-related functions. Therefore, this AMP is rated a Medium priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, because despite our requests, the team did not have access at this plant to the CR database Passport/Portal J. This made a thorough evaluation of the effectiveness and implementation much more difficult than at earlier AMP effectiveness audits at Ginna and NMP-1.

5.2.11.3 Recommendations for Subsequent License Renewal

5.2.11.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.11.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

M20.0-1: ***Recommendation*:** This AMP is rated a Medium priority for future AMP audits.
***Technical Basis*:** The Open-Cycle Cooling Water System Program continues to be necessary to the management of aging effects in

the open-cycle cooling water system. While these aging effects do not generally result in immediate safety concerns, they do potentially impact the long-term reliability of SSCs having safety-related functions.

1. <u>Scope of Program</u>:

As stated above, two enhancements were made to the RNP AMP B.3.5 Program Element 4 ("Detection of Aging Effects") as a part of the license renewal process. These enhancements are as follows:

- An action was initiated under the site Preventive Maintenance Program to periodically replace cooling coils in certain room coolers. The old copper tubes were replaced with tubes fabricated of the austenitic alloy AL-6XN.

- A requirement to perform a one-time volumetric inspection of the CCW heat exchanger tubes prior to the end of the initial license period was incorporated into the One-Time Inspection Program.

In addition to the above, the four containment air coolers, which had been replaced in 1990, are being inspected by EC on a rotating basis, with one inspection during each outage. No problems have been detected to date.

In response to a reviewer's question, RNP stated that their service water was obtained from Lake Robinson, and that the only treatment applied was chlorination and screening to remove larger particles. In particular, they did not follow EPRI service water quality guidelines (EPRI 1025318 and EPRI 1010059), nor are these guidelines referenced in any of the revisions of the GALL Report.

RNP updated the program basis document, "Aging Management Program, Open Cycle Cooling Water System Program," in June 2004 by adding several references and minor details. RNP did not make substantive changes to and did not update information in the program basis document to reflect recent developments, such as changing the commitment for periodic replacement of certain room coolers and scheduling periodic inspections as a result of the CCW heat exchanger volumetric examination. The staff considers the program basis document to be of historical value only, since it did not provide any ongoing insights into the program's implementation.

No further review item identified.

2. <u>Preventive Action</u>:

No review item identified.

<u>3. Parameters Monitored/Inspected:</u>

As stated above, the four containment air coolers, which had been replaced in 1990, are being inspected by EC on a rotating basis, with one inspection during each outage. No problems have been detected to date.

No further review item identified.

4. Detection of Aging Effects:

Two enhancements were made to this program element in RNP AMP B.3.5 as described under Program Element 1 ("Scope of Program") above.

No further review item identified.

5. Monitoring and Trending:

No review item identified.

6. Acceptance Criteria:

No review item identified.

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

During the audit, RNP stated that their Service Water System had experienced numerous problems during early plant operations. This is borne out by early OpE, as described in LERs 83-003-00 ("Service Water Leak in Containment Fan Cooler HVH-3"), 83-022-00 ("Service Water Leak in Containment Fan Cooler HVH-2"), and 87-029-00 ("Service Water Flange Leak in Containment").

However, RNP stated that these problems had been vigorously addressed, and the license renewal SER issued in 2004 noted no significant deficiencies in the program.

Subsequent to license renewal, there have been a several OpE events of note. These events are mentioned in the Service Water System Health Report for the Third Quarter of 2012 (Dec. 3, 2012) and were further discussed during the audit. In the first event, the report discusses a leak in the open-cycle cooling water system discovered in December 2010 that resulted in an unplanned LCO event in June 2011 due to worsening leakage. The leakage issue was resolved through the installation of a temporary modification.

In addition, problems have been encountered with the underground main headers, which are the primary supply and return lines for the service water system. These lines are fabricated of carbon steel with an inner concrete mortar lining approximately 3/8-in. thick. In recent years, small pieces of the mortar lining have spalled off and become embedded in the “B” closed-cycle cooling water heat exchanger. A repair order was put in place for the north header, which was determined to be the source of the problem. Repair alternatives include coating or re-lining the inner surface of the piping to stabilize the mortar lining, or both headers may be replaced with above-ground piping. RNP stated the both headers were inspected internally in 1990; the north header has been inspected three times since then and the south header is to be inspected for the first time since 1990 during the next outage. The headers are approximately 900 to 1000 feet in length.

Another problem that has arisen is higher than normal vibration in service water pump “C.” Spectral analysis of the vibration signature has determined that the vibration is not due to an internal balance problem (e.g., a degraded impeller) but rather improper mounting and shimming. A pump base redesign has been developed and is to be put into place.

RNP also stated that all of the old rubber-lined aluminum service water piping providing cooling water to the diesel generators has been replaced with stainless steel piping because of leakage problems. In addition, all of the service water carbon steel heat exchanger surfaces have been coated to control corrosion, and the coating of choice is Chesterton ARC855, a polymer ceramic coating.

This OpE indicates that RNP AMP B.3.5 appears to be functioning effectively in that it is identifying and addressing aging-related problems.

M20.10-1: *Recommendation*: A more comprehensive approach should be considered for managing aging in open-cycle cooling water systems beyond the specific activities in GL 89-13.
***Technical Basis*:** The staff notes that the GALL AMP implements GL 89-13 activities, which are rooted in operational issues relating to flow-blockage. In light of subsequent industry-wide OpE with open-cycle cooling water systems, it is proposed that a more comprehensive approach be considered for managing aging in these systems beyond the specific activities in GL 89-13.

5.2.12 Closed Treated Water System (XI.M21A)

5.2.12.1 Objective and Scope of the AMP

The RNP Closed-Cycle Cooling Water System Program B.2.5 is an existing program that is credited for mitigating the aging effects of loss of material due to general, crevice, pitting, and galvanic corrosion, loss of material due to leaching, cracking due to SCC, and loss of heat transfer effectiveness due to fouling of heat transfer surfaces. The components for which aging management is accomplished are found in the following plant systems:

- Component Cooling Water (CCW) System
- Diesel Generator System
- Dedicated Shutdown Diesel Generator System
- Engineered Safety Features/Technical Support Center (ESF/TSC) Security Diesel Generator System

The RNP LRA states that chemistry is regularly monitored and maintained within standards in accordance with EPRI and/or manufacturer's recommendations. The Component Cooling Water and Emergency Diesel Generator jacket water employs chromate chemistry. The Dedicated Shutdown and EOF/TSC Security Diesel Generator jacket water utilizes a glycol solution supplemented with corrosion inhibitors.

5.2.12.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.12.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The RNP Closed-Cycle Cooling Water System Program B.2.5 was developed and implemented to meet industry guidance based on the EPRI water chemistry guidelines then in effect and cited in GALL Rev. 0. Since that time, RNP has continued to modify it program to conform to updated EPRI guidance as it is published and endorsed by the NRC. This is in conformance with the GALL Rev. 2 guidance on use of later editions/revisions of various industry documents. The EPRI guidance currently in use is that given in EPRI 1007820, which was published in 2004.

The RNP LRA states that this AMP is consistent with GALL, Rev. 0 Section XI.M21, “Closed-Cycle Cooling Water System,” and no exceptions or enhancements are identified. Commitment 8 in Appendix A of the RNP SER (NUREG-1785) states that the RNP Closed-Cycle Cooling Water System Program is credited with managing aging in this system with no changes required.

5.2.12.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M2 Program Priority for Future Audits: The Closed-Cycle Cooling Water System Program continues to be critical to the management of significant aging mechanisms in SSCs important to safety, and industry guidance is periodically updated. Therefore, this AMP is rated a High priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, because despite our requests, the team did not have access at this plant to the CR database Passport/Portal J. This made a thorough evaluation of the effectiveness and implementation much more difficult than at earlier AMP effectiveness audits at Ginna and NMP-1.

5.2.12.3 Recommendations for Subsequent License Renewal

5.2.12.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.12.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M21A.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The Closed-Cycle Cooling Water System Program continues to be critical to the management of significant aging mechanisms in SSCs important to safety, and industry guidance is periodically updated.

1. Scope of Program:

The RNP Closed-Cycle Cooling Water System Chemistry Program is consistent with GALL, Rev. 0 AMP XI.M21, “Closed-Cycle Cooling Water System” with no exceptions or enhancements.

During the audit, RNP stated that it presently follows the most recent EPRI water chemistry guidance, namely EPRI 1007820, "Closed Cooling Water Chemistry Guideline, Revision 1: Revision 1 to TR-107396, Closed Cooling Water Chemistry Guideline," which was published April 2004. As is the case with the RNP Water Chemistry Program (AMP B.2.2), future updated guidance is typically incorporated into the RNP Closed-Cycle Cooling Water System Program within six months after approval by the NRC, though this timing could be extended somewhat by an intervening refueling outage.

Because the RNP Water Chemistry Program is periodically updated to conform to the most recent EPRI guidance and includes loss of heat transfer effectiveness due to fouling of heat transfer surfaces, it appears to be consistent with the GALL Rev. 2 AMP XI.M21A.

RNP updated the program basis document, "Aging Management Program Closed Cycle Cooling Water System Program," in June 2004, by adding several references and minor details. RNP did not make substantive changes to and did not update information in the program basis document to reflect recent developments. The staff considered the program basis document to only be of historical value, since it did not provide any ongoing insights into the program's implementation.

No further review item identified.

2. <u>Preventive Action</u>:

No review item identified.

3. <u>Parameters Monitored/Inspected</u>:

According to the RNP "One Time Inspection Program License Renewal Commitment" document, the "B" CCW heat exchanger was re-tubed (with AL-6XN tubes) during RO-25. A population of the existing tubes were pulled and measured to obtain the "as found" tube wall. From this data, it was determined that the "A" CCW heat exchanger should also be re-tubed during RO-26. This was completed, and tube wear was found to be as predicted. Preventive maintenance activities have been established to perform eddy current testing for both heat exchangers on a 6-year frequency. This activity is also discussed in Section 5.2.19, XI.M32 ("One-Time Inspection").

4. <u>Detection of Aging Effects</u>:

No review item identified.

5. <u>Monitoring and Trending</u>:

No review item identified.

6. Acceptance Criteria:

No review item identified.

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

The RNP System Health Report for the component cooling water system included a discussion under “Other Concerns” about the degradation of rubber lined butterfly valves that caused a foreign material issue in the component cooling water “B” pump. The report indicated that the long-range asset management project to replace the two valves of concern was approved and budgeted for a near-term refueling outage. The NRC staff considered this issue to be similar to the wall thinning identified downstream of the spent fuel pool heat exchangers in that it was component-specific age-related degradation and would be appropriately managed through a comparable AMP such as the Preventive Maintenance Program in lieu of incorporating this aspect into the Closed Treated Water System Program.

Subsequent to license renewal, there have been a couple of OpE events of note. These events are mentioned in the Component Cooling Water System Health Report for the Third Quarter of 2012 (Dec. 3, 2012) and were further discussed during the audit. The first of these had to do with needed repairs to two leaking spent fuel pool heat exchanger drain valves in the treated water system. The first of these valves could not be replaced in January 2012 due to system leakby, and the second could not be corrected due to blockage in the line. A repair plan has been developed by the system engineer, and the next opportunity to perform this work is in January 2013, since the work must be carried out during a winter month because of spent fuel pool SFP cooling requirements.

The second problem area noted was the degradation of the rubber lining in butterfly valves, resulting in pieces of rubber causing problems with pump “B.” The valves in question had been in service for many years, and the degradation had apparently occurred in the 1980’s, when operating conditions resulted in contact with excessively high-temperature water and steam that broke down the rubber lining. Changes in operating procedures have since eliminated butterfly valve contact with steam, but the pieces of rubber resulting from the earlier degradation had remained in the system and eventually became lodged in the pump. The degraded butterfly valve had been replaced with a similar design during RO-26, and the long-term plans are to replace all such valves with a design that does not have a rubber lining.

This OpE indicates that RNP AMP B.2.5 appears to be functioning effectively in that it is identifying and addressing aging-related problems.

5.2.13 Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems (XI.M23)

5.2.13.1 Objective and Scope of the AMP

The RNP AMP B.3.6, Overhead Heavy and Light Load Handling Systems Program, is credited for aging management of the following crane lifting devices at RNP:

- Containment Polar Crane
- Spent Fuel Cask Crane
- Turbine Gantry Crane
- Spent Fuel Bridge Crane

The aging effect/mechanism of concern is loss of material due to corrosion. The turbine gantry crane and spent fuel cask crane are subject to semi-annual preventive maintenance inspections. A similar inspection is performed annually for the spent fuel bridge crane and at each refueling outage for the polar crane.

The licensee noted that many of the systems and components of these cranes perform an intended function with moving parts or with a change of configuration, or subject to replacement based on qualified life, and thus are not within the scope of license renewal or the AMP. The LRA states that the program is primarily concerned with structural components that make up the bridge and trolley.

As a result of the license renewal review, enhancements were made to program element 1 (Scope of Program) to: (1) add the turbine gantry crane as a system requiring walkdown for license renewal purposes, (2) note that cranes are to be inspected using the attribute inspection checklist for structures, and (3) revise the attribute inspection checklist for structures to include GALL terminology, such as wear. The reason for the first item in this enhancement is that this program was originally implemented under the Maintenance Rule (10 CFR 50.65). At the time of license renewal, the turbine gantry crane was added because it was within the scope of license renewal but outside the scope of the Maintenance Rule. The second and third items were added to bring the program into conformance with GALL Rev. 0 AMP XI.M23.

5.2.13.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.13.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. During the license renewal process, the licensee was asked in RAI B.3.6-2 to provide a summary of the attribute inspection checklist referred to in the program enhancement described in Section 5.1.13.1. In response, the licensee provided a detailed checklist and modified the USFAR Supplement to explicitly address the subject of wear (NUREG-1785). In response to the related RAI 6.3.6-3, the licensee verified that the effects of wear on crane rails are managed as a part of the program.

5.2.13.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M23 Program Priority for Future Audits: The Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems Program is based on mature technology, but proper functioning of the lifting systems managed by this program is important to plant safety. Therefore, this AMP is rated a Medium priority for future AMP audits.

5.2.13.3 Recommendations for Subsequent License Renewal

5.2.13.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.13.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M23.0-1: ***Recommendation*:** This AMP is rated a Medium priority for future AMP audits.
***Technical Basis*:** The Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems Program is based on mature technology, but proper functioning of the lifting systems managed by this program is important to plant safety.

1. <u>Scope of Program</u>:

The RNP Overhead Heavy and Light Load Handling Systems Program is consistent with GALL Rev. 0 AMP XI.M23 with the addition of the enhancement described in Section 5.1.13.1. The licensee's responses to RAIs B.3.6-2 and B.3.6-3 concerning the details of the attribute inspection checklist, the inclusion of wear of crane rails as degradation effect, and the qualifications of personnel performing crane inspections were found to be acceptable during the license renewal process, as described in the SER (NUREG-1785).

M23.1-1: *Recommendation*: Air-outdoor should be added as a service environment in GALL for cranes in Table VII.B of GALL Rev. 2.
***Technical Basis*:** The spent fuel cask cranes at RNP are exposed to an outdoor environment that causes continuing corrosion problems and some part of the cranes are difficult to access for repainting or otherwise correcting degradation due to corrosion. In addition, the RNP crane quick-hit self-assessment discussed a recent event in which an electrical fault occurred due to degraded wiring in the crane system. The fault caused the crane to become inoperable and resulted in outage delays. The degraded wire was caused by aging and the harsh outdoor service environment. GALL Rev. 2 lists only air-indoor, uncontrolled as the service environment for cranes.

M23.1-2: *Recommendation*: Crane system brass shear pins exposed to borated water should be added to the list of components subject to an aging management review listed in Table VII.B of GALL Rev. 2. The applicable AMP is XI.M33, Selective Leaching.
***Technical Basis*:** RNP conducted a review of OpE in Institute of Nuclear Power Operations (INPO) Equipment Performance and Information Exchange (EPIX) database applicable to RNP fuel handling equipment, including polar and gantry cranes. The majority of the failures identified in the search dealt with shear pins that have experienced dezincification due extended immersion in the spent fuel pool borated water. At RNP, the pins and similar mechanical parts are continuously submerged in the spent fuel pool. The shear pin is a safety device designed to shear off in case of mechanical overload and dezincification is a process of selective leaching. During the audit, RNP stated that the shear pens are considered parts of active components in the refueling equipment and are thus not in the scope of license renewal. However, it is the staff's opinion that the shear pin is a passive component subject to aging management, since it is not a moving part, does not undergo a change in configuration or properties during normal service, and is not subject to replacement based on qualified life.

2. <u>Preventive Action</u>:

No review item identified.

3. <u>Parameters Monitored/Inspected</u>:

No review item identified

4. <u>Detection of Aging Effects</u>:

No review item identified.

5. Monitoring and Trending:

No review item identified.

6. Acceptance Criteria:

No review item identified.

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

The licensee's Crane System Health Report for third quarter 2012 stated that the trend in system health is declining due to continuing corrosion problems with the spent fuel cask crane. The licensee indicated that there are engineering concerns regarding the spent fuel cask crane with regards to obsolescence, margin, and painting.

During the audit, the licensee explained that the spent fuel cask cranes are exposed to outdoor environment that causes continuing corrosion and that some parts of the crane are difficult to paint due to inaccessibility.

The majority of the equipment failures identified by the licensee are related to shear pins that experienced dezincification. The dezincification is due to the pins and similar mechanical parts being continuously submerged in borated water for an extended period in the spent fuel pool. These shear pins do not serve a license renewal function, and are not included in a license renewal-credited AMP. The licensee said that the majority of the equipment failures associated with cranes is of active and electronic components, also not subject to license renewal AMPs.

The RNP crane quick-hit self-assessment (Feb. 2012) states that they reviewed a 12-year history of corrective and preventive maintenance work orders for the polar, turbine gantry, and spent fuel pool bridge cranes to identify components that have had repeated problems and regular parts usage. The most reoccurring problems dealt with the automatic rail clamps and the hydraulic bridge brakes on the turbine crane. The self-assessment recommended modifying/removing automatic rail clamps to prevent the maintenance burden. During the audit, RNP stated after appropriate corrective actions were taken, there have been no further issues related to the rail clamps and brakes.

Finally, during the audit, RNP stated that they would review the three significant crane wire rope failures documented in NRC IN 2009-20, “Degradation of Wire Rope Used in Fuel Handling Applications” and determine if they have any applicability to the RNP cranes.

5.2.14 Fire Protection (XI.M26)

5.2.14.1 Objective and Scope of the AMP

RNP implements GALL Report AMP XI.M26 Fire Protection through its existing AMP B.3.1, “Fire Protection.” The program is based on GALL Rev. 0 (NUREG-1801, GALL Report, 2001). The program manages the aging effects applicable for fire barriers (fire barrier walls, ceilings, floors, penetration seals, and fire doors) and nonwater-based fire suppression systems such as halon and carbon dioxide. The AMP is effective in monitoring loss of material and cracking via visual inspection and testing of penetration seals, fire barrier walls, ceilings and floors, cable coatings, fire wraps and fire-rated doors to verify that these components continue to perform their intended functions. The AMP also has been effective for fire pumps and fuel supply line for maintaining their intended functions.

The program requires periodic visual inspection of fire barrier penetration seals and fire doors to ensure their function is maintained. The program also includes periodic inspection and test of the halon and carbon dioxide fire suppression systems and the diesel-driven fire pumps. The diesel-driven fire pump inspection requires the fire pump be periodically tested to ensure that the fuel supply line can perform its intended function. The program is consistent with GALL XI.M26 with the following exceptions and enhancements.

Exceptions:

1. Inspection frequency of fire doors in the GALL AMP specifies bi-monthly inspections, whereas, RNP performs detailed inspections semi-annually, augmented by frequent inspections during operator rounds and additional inspections under system/structural monitoring procedures.

2. Inspection interval of fire barriers in the RNP program is based on safety significance of fire barriers, not to exceed 10 years, whereas, refueling frequency is specified in GALL.

3. Valve alignment and system status are not verified each month. Operator procedures check valve position and system status subsequent to any system realignments, and as needed, to support plant operation. Current procedures/practices deemed acceptable for the current license period are considered to be sufficient for the period of extended operation.

4. Visual inspections of fire barriers under systems and structures monitoring procedures are performed at a level of scrutiny deemed necessary by trained personnel to ensure operability, but are not specifically required on a level of detail commensurate with VT-1 inspections criteria.

Enhancements:

LRA Commitment #12 states that prior to the period of extended operation, the RNP AMP B.3.1 will be enhanced to note that concrete surface inspections performed under structures monitoring procedures will be credited for inspection of fire barrier walls, ceilings, and floors (NUREG-1785).

5.2.14.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.14.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

(a) Provide clear guidance regarding how other AMPs such as XI.S5 or XI.S6 may interface with XI.M26, when they are credited to manage the aging effects on any of the fire barriers to ensure their operability.

(b) Include performance tests of motor-driven and diesel-driven fire pumps to ensure operability of the pumps and the integrity of the fuel line.

One good practice or strength of the AMP was identified in this review. RNP performs periodic quick hit self-assessment of AMP every three years, including the fire protection system.

5.2.14.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Include aging management of elastomer flexible hose and couplings in CO_2, Halon, and CARDOX system, in the GALL AMP XI.M26.

(b) Include additional guidance to address issues related to inaccessibility of fire barriers.

(c) Expand the scope of program to include management of delamination and separation of elastomer seal materials in the fire barrier penetrations due to differential movement and vibration.

5.2.11.3 Recommendations for Subsequent License Renewal

5.2.14.3.1 Good Practices or Strengths of the AMP

M26.S-1: *Recommendation*: Performing periodic self-assessment of the AMP is considered a good practice or strength of the program.
***Technical Basis*:** RNP performs periodic quick hit self-assessment of the Fire Protection AMP every three years.

5.2.14.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M26.0-1: *Recommendation*: The program description should be revised to provide clear guidance regarding how other AMPs such as XI.S5 or XI.S6 may interface with XI.M26, when they are credited to manage the aging effects on any of the fire barriers to ensure their operability.
***Technical Basis*:** As stated in the RNP license renewal Commitment #12, the RNP Fire Protection Program B.3.1 was enhanced to note that the concrete surface inspections performed under the Structures Monitoring Program B.3.15 procedures are credited for inspection of fire barrier walls, ceilings, and floors (NUREG-1785). In addition, GALL Rev. 2 AMP XI.S5 Scope of Program, states, "The aging effects on masonry walls that are considered fire barriers also are managed by AMP XI.M26 Fire Protection Program, as well as being managed by this program. Furthermore, the XI.M26 Program Description states, "For license renewal, masonry walls may be inspected as part of the Structures Monitoring Program (XI.S6) conducted for the Maintenance Rule, provided the 10 attributes described below are incorporated in AMP XI.S6. Therefore, based on the description of GALL AMP XI.S5 it is clear that irrespective of whether the fire barrier masonry walls are inspected under AMP XI.S5 (or XI.S6 if it includes the 10 elements of XI.S5), these fire barriers are also inspected under the XI.M26 AMP to ensure their intended function during the period of extended operation.

If another AMP is credited to manage the effects of loss of material and cracking, increased hardness, shrinkage and loss of strength on the intended function of the concrete fire barriers, the program description of XI.M26 should be revised to provide clear guidance regarding how the other AMPs may interface with XI.M26.

M26.0-2: *Recommendation*: Expand description to include performance tests of motor-driven and diesel-driven fire pumps to ensure operability of pumps and integrity of fuel line.
***Technical Basis*:** The RNP Fire Protection AMP includes both motor-driven and diesel-driven fire pump performance test that is not included in GALL, Rev. 2. RNP fire engineers believed the fire pump performance test should be included in the AMP because the test ensures no degradation of the fuel line. The function test of firewater pump had been in in GALL Rev 0, but was removed from GALL Rev. 2 AMP. It is recommended that this activity should be included in XI.M26 AMP for subsequent license renewal guidance document.

1. <u>Scope of Program</u>:

M26.1-1: *Recommendation*: Include aging management of elastomer flexible hose and couplings in CO_2, Halon, and CARDOX system, in the GALL AMP XI.M26.
Technical Basis: The RNP Fire Protection AMP includes aging management of changes in material properties and cracking, due to exposure to elevated temperature, of elastomer flexible hoses and couplings in CO_2, Halon, and CARDOX systems. Aging degradation of these components is not addressed in the GALL Report. It is recommended to include these components (elastomeric hose and couplings in CO_2, Halon, and CARDOX system) in the GALL AMP XI.M26.

M26.1-2: *Recommendation*: Include additional guidance to address issues related to inaccessibility of fire barriers.
Technical Basis: The RNP engineer stated that some of the fire barrier penetrations and fire dampers are located 30 ft. above floor and/or in radiation areas. Inaccessibility of some components could prevent inspection of all fire barriers, and make the inspection results inconclusive. The AMP XI.M26 scope of the program may be revised to include additional guidance to address inaccessibility of fire barriers.

2. <u>Preventive Action</u>:

No further review item identified.

3. <u>Parameters Monitored/Inspected</u>:

M26.3-1: *Recommendation*: Expand the scope of program to include management of delamination and separation of elastomer seal materials in the fire barrier penetrations due to differential movement and vibration.
Technical Basis: The Parameters Monitored/Inspected program element of the RNP Fire Protection Program includes management of delamination and separation of elastomer seal materials in the fire barrier penetrations due to differential movement and vibration. These aging effects are not included in the GALL AMP XI.M26.

4. <u>Detection of Aging Effects</u>

No further review item identified.

5. <u>Monitoring and Trending</u>:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

Delamination and separation due to differential movement or vibration was observed in elastomer seal materials in the fire barrier penetrations.

5.2.15 Fire Water System (XI.M27)

5.2.15.1 Objective and Scope of the AMP

The RNP Fire Water System program B.3.7 is based on GALL Rev. 0. The program manages the aging effects of loss of material and flow blockage due to fouling of fire water systems. The program relies on testing of the water-based fire protection system piping and components in accordance with applicable NFPA commitments. Periodic full flow flush testing, system performance testing, and inspections during maintenance are conducted to ensure no significant corrosion, MIC, or biofouling has occurred in the water-based fire protection system. Also, the system is normally maintained at required operating pressure and is monitored such that loss of system pressure would be detected, and corrective actions initiated. The aging effects/mechanisms of concern in this program are:

- Flow Blockage due to Fouling
- Loss of Material due to Crevice Corrosion
- Loss of Material due to Galvanic Corrosion
- Loss of Material due to General Corrosion
- Loss of Material due to MIC
- Loss of Material due to Pitting Corrosion

The program is enhanced to include field service testing of sprinkler heads in accordance with NFPA 25 once prior to the period of extended operation and another 10 years into the extended operation. The RNP program also has an exception; for the flow tests portion of the sprinkler system that are not routinely subjected to flow, the program proposed to perform the flow tests in accordance with GALL, or by performing internal inspections or UT examinations of the sprinkler system that are not routinely subjected to flow. The applicant's proposed exception is consistent with, "Interim Staff Guidance (ISG)-04: Aging Management of Fire Protection Systems for License Renewal," dated December 3, 2003.

During the audit, RNP engineer explained that the fire water systems use lake water. The AMP performs periodic sampling and analysis of the fire water systems for the presence of bacteria and microbiological contamination. RNP engineer provided documents that indicate bacterial limit tests had been consistently passed in the nine tests conducted between March 2011 and December 2012. The RNP engineer also mentioned that there is no MIC or very minor MIC in the fire water piping. Chlorination is not used for the RNP Fire Water System; it is used only for service water. In addition, unintended consequences from excessive biocide treatment (e.g., chlorination) causing wall thinning are not an issue for the RNP fire water systems. The RNP engineer further stated that the RNP fire water piping did not have the issue of formation of tubercules which have been observed in the Ginna fire water piping.

Fire hose stations and hydrant hose houses are inspected monthly for physical defects, missing or poor material condition. Yard hydrants are inspected annually, including hydrostatic hose testing, gasket inspections, and flow testing /flushing. Sprinkler systems are inspected each refueling, as a minimum. All sprinkle heads will be replaced after 50 years use, no test needs to be performed.

RNP requires the following activities of the fire suppression water supply system to demonstrate its operability:

- Weekly starting the diesel-driven fire pump and operating for at least 30 minutes. Weekly starting the electric-motor-driven fire pump and operating it for at least 10 minutes.
- Monthly verifying of each isolation valve in the fire water distribution piping flow path.
- Annually cycling of fire water systems valves through at least one complete cycle of full travel, except for the fire water system valves in containment which shall be cycled every refueling.
- Annually performing pump flow test to verify each pump develops specified system pressure.

5.2.15.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.15.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

It is recommended that galvanic corrosion of dissimilar metal joints in the fire water piping system should be included as a potential aging degradation mechanism in the program description of the GALL AMP XI.M27 Fire Water System.

One good practice or strength of the AMP was identified in this review. RNP performs periodic quick hit self-assessment of AMP every three years, including the fire water system.

5.2.15.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Include aging effect of wall thinning due to general corrosion of the external surface of the fire pump bowl (or casing) in the “splash zones.”

(b) Include mitigation of galvanic corrosion in the fire water piping by avoiding dissimilar metal fittings without a dielectric insulator.

(c) Include the RNP and Monticello OpE related to loss of material due to dissimilar metal galvanic corrosion.

5.2.15.3 Recommendations for Subsequent License Renewal

5.2.15.3.1 Good Practices or Strengths of the AMP

M27.S-1: *Recommendation*: Performing periodic self-assessment of the AMP is considered a good practice or strength of the program.
***Technical Basis*:** RNP performs periodic quick hit self-assessment of the Fire Water System AMP every three years.

5.2.15.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M27.0-1: *Recommendation*: It is recommended that galvanic corrosion of dissimilar metal joints in the fire water piping system should be included as a potential aging degradation mechanism in the program description of the GALL AMP XI.M27 Fire Water System.
***Technical Basis*:** The RNP self-assessment report of the fire water system conducted in Nov. 2012 noted failure due to galvanic corrosion of the fire water piping in regions where repairs were made by joining dissimilar metals (e.g., aluminum pipe and bronze fittings) without proper separation or dielectric insulator between them. As a result of this observation, RNP conducted an inspection of aluminum piping 2 inch or smaller for pipe unions to avoid a repeat of such connections that may lead to galvanic corrosion in the presence of an electrolyte. They also conducted such inspection in the auxiliary building, and fuel handling building, and found two other potential precursors to galvanic corrosion. During the audit, the RNP engineer recommended that galvanic corrosion of dissimilar metal joints in the fire water piping system should be included in the GALL AMP XI.M27.

1. Scope of Program:

M27.1-1: *Recommendation*: It is recommended that aging effect of wall thinning due to general corrosion of the external surface of the fire pump bowl (or casing) in the “splash zones,” be included in the GALL AMP XI.M27.
Technical Basis: The RNP LRA OpE documents failure of the fire pump casings due to general corrosion and thinning in the “splash zones.” In addition, LRA Table 3.3-2 item 30 states that the RNP diesel- and motor-driven fire pump casings are replaced every 10 years in accordance with the Preventive Maintenance Program to manage degradation caused by corrosion of the external surface of the pumps in the “splash zone.” However, the NRC SER confirmatory item 3.3.2.3.3-1 noted an error RNP LRA. The fire pumps do not have casings, rather the vertical shaft pumps use bowls for the pressure boundary function. Furthermore, the inspection indicated that these bowls are not replaced on a 10-year cycle; rather the pumps are overhauled on a 10-year cycle, which

includes inspection of the pressure retaining portion of the bowl. The overhaul does not specifically require replacement of the bowls.

2. Preventive Action:

M27.2-1: ***Recommendation*:** Update this program element to include mitigation of galvanic corrosion in the fire water piping by avoiding dissimilar metal fittings without a dielectric insulator between them.
***Technical Basis*:** As discussed in the program description comment M27.1-1 and OpE comment M27.10-1 RNP noted failure due to galvanic corrosion of the fire water piping in regions where repairs were made by joining dissimilar metals (e.g., aluminum pipe and bronze fittings) without proper separation or dielectric insulator between them. It may be prudent to update the preventive action program element to include a statement that dissimilar metal fittings in the fire water piping system, without a dielectric insulator between them, should be avoided to mitigate galvanic corrosion of such dissimilar metal connections.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M27.10-1: *Recommendation*: Include the RNP and Monticello OpE related to loss of material due to dissimilar metal galvanic corrosion in element 10 of the GALL AMP XI.M27.
Technical Basis: Most recent self-assessment report of the fire water system conducted on Nov. 2012, recommended that several internal and industry OpE events be added to the commitment binder, including the dissimilar metal galvanic corrosion related failure at RNP in 2010 and the 2011 OpE of the fire water system AMP at Monticello. The RNP engineer noted that one of the fire water line came apart due to a pressure surge caused by the starting of the fire pump. This was traced back to a pre-1983 pipe repair when welded aluminum piping was repaired using threaded brass piping and bronze fittings. The joining of the aluminum pipe and bronze fittings without a dielectric insulator between them resulted in the corrosion of the aluminum pipe through galvanic corrosion in the presence of an electrolyte. Based on these observations, RNP recommended including galvanic corrosion in the GALL AMP XI.M27 Fire Water System.

The RNP operating experience indicates failures of the fire pump casings due to wall thinning in the "splash zones." The licensee confirmed that wall thinning at the splash zones is due to general corrosion, not from erosion. The licensee indicated that this aging mechanism is managed by replacing the pump casings every 10 years by the RNP Preventive Maintenance Program. The licensee also indicated that no pump casing failures have been documented since the implementation of the Preventive Maintenance Program.

The licensee implemented minor changes to the scope of the Preventive Maintenance Program. The licensee indicated that testing for bacteria has been completed since 2010 and that no degradation problems associated with chlorination have been identified. The licensee also indicated that there is no microbiological induced corrosion (MIC) or very minor MIC in the fire water piping which uses the lake water and that unintended consequences from excessive biocide treatment (e.g., chlorination) causing wall thinning are not an issue. During the PEO, the licensee will test representative samples of above ground fire water system using nonintrusive techniques (e.g., volumetric testing) or an internal inspection will be completed at a 10-year interval to identify evidence of loss of material due to corrosion. The NRC staff noted that some site-specific procedures have been implemented in the licensee's plant fleet, such as the model system walkdown commitment.

As a result of galvanic corrosion conditions noted in the RNP Corrective Action Program, the licensee conducted an inspection of aluminum piping, 2-inch or smaller, for pipe unions. The licensee performed the inspection to avoid a recurrence of an event where joining of the pipe and bronze fittings, without a dielectric insulator between them, resulted in the corrosion of the aluminum through galvanic corrosion in the presence of an electrolyte. The licensee conducted this inspection in the auxiliary and fuel handling

buildings, and observed two other potential precursors to galvanic corrosion which were documented in the RNP corrective action program.

The RNP Corrective Action Program also described an event in which the fire water line 2-FP-29 came apart due to a pressure surge caused by the starting of the fire pump. The licensee corrective actions included performing an extent condition walkdown of the fire water piping system in the power block. As a result, the licensee corrected areas of piping where other dissimilar metals were identified. The licensee also revised a plant procedure to add information that the fire water piping in the power block uses aluminum piping that is subject to galvanic corrosion if repairs are made with dissimilar metals without proper separation/insulation.

5.2.16 Above Ground Metallic Tanks (XI.M29)

5.2.16.1 Objective and Scope of the AMP

The RNP AMP B.3.9 is a collection of activities under administrative controls at RNP that is considered to constitute a separate program. This program is described in the RNP LRA as being consistent with GALL Rev. 0 AMP XI.M29, Above Ground Carbon Steel Tanks, with exceptions and enhancements, and is credited for aging management of loss of material due to general corrosion at the exterior surfaces of tanks in the Fuel Oil System at RNP. Aging management is accomplished through visual inspections conducted during periodic system walkdowns.

The RNP program takes exception to GALL XI.M29 with respect to Program Elements 4 (Detection of Aging Effects) and 6 (Acceptance Criteria) in that thickness measurements are not performed on tank bottoms to detect exterior corrosion, because the tanks are protected from corrosion by a cathodic protection system and the tanks are located on a layer of oily sand. These measures are described in the RNP LRA as providing better aging management of tank bottom degradation than detection of corrosion by thickness measurement.

As a result of the license renewal review, program elements 5 (Monitoring and Trending) and 6 (Acceptance Criteria) for this program were enhanced to assure that the external surfaces of the fuel oil tanks are inspected periodically and to include, in the administrative controls for the Program, a section specifically addressing corrective actions.

5.2.16.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.16.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. As stated above, the RNP “Above Ground Carbon Steel Tanks Program” B.3.9 is actually a collection of activities under administrative controls at RNP that have been combined to constitute the present program. The exception to GALL Rev. 0 noted above was the subject of several RAIs during the license renewal process, particularly with respect to the cathodic protection system and plant-specific OpE with internal degradation. In its response, RNP credited other programs (Fuel Oil Chemistry or Buried Piping and Tanks) for maintaining the cathodic protection system and

preventing internal degradation. The staff found this response to be acceptable. The original application was reviewed and accepted in accordance with the recommendations of GALL Rev. 0.

5.2.16.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M29 Program Priority for Future Audits: The Above Ground Carbon Steel Tanks Program is based on mature technologies, and OpE, both at RNP and industry-wide, has not generally indicated significant problems with these components. Therefore, this AMP is rated a Low priority for future AMP audits.

5.2.16.3 Recommendations for Subsequent License Renewal

5.2.16.3.1 Good Practices or Strengths of the AMP

No review item identified.

5.2.16.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M29.0-1: *Recommendation*: This AMP is rated a Low priority for future AMP audits.
***Technical Basis*:** The RNP B.3.9 program is based on mature technologies, and OpE, both at RNP and industry-wide, has not generally indicated significant problems with these components.

1. Scope of Program:

The RNP B.3.9 program differs from GALL Rev. 0 AMP XI.M29 with respect to the exceptions and enhancements described above. The exception to GALL Rev. 0 was the subject of several RAIs during the license renewal process, particularly with respect to the cathodic protection system and plant-specific OpE with internal degradation. In its response, RNP credited other programs (Fuel Oil Chemistry or Buried Piping and Tanks) for maintaining the cathodic protection system and preventing internal degradation. The staff found this response to be acceptable. The original application was reviewed and accepted in accordance with the recommendations of GALL Rev. 0.

Subsequent to license renewal, a weakness was identified with respect to incorporating generic OpE outside the existing scope of the program. Industry OpE since the implementation of the program indicates that stainless steel exposed to outdoor air can

experience aging effects, such as cracking or through-wall pitting. When the RNP program was implemented, GALL did not identify any aging effects for stainless steel in an outdoor environment and stainless steel tanks were not included in the RNP program. Since these stainless steel tanks were not in the scope of the program, the industry OpE with stainless steel degradation was not reviewed by the owner of the program. During the AMP effectiveness audit, the licensee noted this as a weakness and initiated a condition report to review industry OpE with stainless steel exposed to outdoor air, and to update the program as necessary.

M29.1-1: *Recommendation*: Additional guidance is needed on how licensees should address OpE in updating their AMPs. The staff needs to ensure that current interim staff guidance on OpE information is clearly captured in the next revision of license renewal guidance documents (GALL and SRP-LR) and that the staff is properly trained on how to review future programs regarding the licensees' effective use of OpE.
***Technical Basis*:** Industry OpE since the preparation of GALL Rev. 0 has shown that stainless steel components are subject to aging effects in an outdoor air environment. Consequently, above ground stainless steel tanks were not within the scope of the original RNP AMP B.3.9. This omission was noted by the licensee as a weakness during the AMP effectiveness audit.

2. Preventive Action:

No review item identified.

3. Parameters Monitored/Inspected:

No review item identified

4. Detection of Aging Effects:

(See discussion of RNP AMP B.3.9 exceptions to GALL AMP XI.M29 in Section 5.2.16.1)

5. Monitoring and Trending:

(See discussion of RNP AMP B.3.9 enhancements to GALL AMP XI.M29 in Section 5.2.16.1)

6. Acceptance Criteria:

(See discussion of RNP AMP B.3.9 exceptions and enhancements to GALL AMP XI.M29 in Section 5.2.16.1)

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

Since implementation of this program, the licensee visual inspections identified minor expected surface corrosion and areas of missing paint which the licensee has repaired as needed. The NRC staff determined that the RNP corrective actions associated with the Aboveground Carbon Steel Tanks program to date are adequate and involve cleaning degraded surfaces and touching up paint as necessary. Also, the NRC staff noted that the number of findings does not indicate a negative trend.

5.2.17 Fuel Oil Chemistry (XI.M30)

5.2.17.1 Objective and Scope of the AMP

The diesel fuel for the HBRSEP Unit 2 is delivered to HBRSEP Unit 1, an adjacent coal-fired generating plant. HBRSEP Unit 2 obtains its diesel fuel supply by pipeline from HBRSEP Unit 1. During the audit, the NRC staff noted that HBRSEP Unit 1 is shut down but not decommissioned, so the fuel oil control system through HBRSEP Unit 1 was still functional.

RNP implements this program through its Fuel Oil Chemistry Program (AMP B.3.10). The aging effects/mechanisms of concern are loss of material due to general, crevice, and pitting corrosion in carbon steel, and loss of material due to MIC in carbon steel, copper alloys, and stainless steel. The RNP LRA states that this program is consistent with GALL, Revision 0, AMP XI.M30 "Fuel Oil Chemistry" with the following exceptions:

- In addition to storage tanks, the program is used to manage aging effects on all system components "wetted" by fuel oil. This results in additional materials being in scope beyond those in GALL.
- Based on operating history and fuel oil management activities, biocides, biological stabilizers, and corrosion inhibitors are not necessary and are not used in the fuel oil at RNP.
- Alternate standards and acceptance criteria are used for fuel oil sampling at RNP, in place of the ASTM standards recommended in GALL.
- UT measurements of bottoms on large storage tanks are not typically performed at RNP, unless warranted by the level of coating degradation and corrosion found during inspection.

5.2.17.2 Effectiveness of the AMP to Meet its Objective

5.2.17.2.1 Adequacy of the Program Description

The auditors pointed out NRC IN 2009-02 ("Biodiesel In Fuel Oil Could Adversely Impact Diesel Engine Performance"). This IN notes that diesel fuel oil containing up to 5% biodiesel can have a cleaning effect that loosens accumulated sediment in fuel oil storage tanks that previously stored conventional diesel fuel. This sediment can then plug filters and other equipment in the fuel oil system. The RNP personnel stated that they did not believe that biodiesel fuel oil had been used at the plant and that they would check on the RNP response to this IN.

The auditors also pointed out IN 2006-22 ("New Ultra-low-sulfur Diesel Fuel Oil Could Adversely Impact Diesel Engine Performance"). This IN notes several potential problems related to the use of ultra-low-sulfur diesel fuel, specifically in the areas of (1) reduced energy content, resulting in increased fuel consumption, (2) fuel particulate buildup, (3) fuel system seal leaks, (4) compatibility with lubricating oil, (5) microbial growth, (6) incompatible metals, and (7) possible reduced lubricity. Again, the RNP personnel stated that they would check on the RNP response to this IN

5.2.17.2.2 Effectiveness and Implementation of the AMP

During the audit, the licensee stated that the fuel oil delivered to the HBRSEP Unit 1 is sampled before it is loaded into the tanker to ensure quality. The tanker is then sealed and no acceptance sampling of fuel oil is performed upon delivery. The audit team noted an incident in which fuel oil delivered to HBRSEP Unit 1 was found to be contaminated by impurities in the tanker. The licensee determined that there is no assurance that the contract carrier tankers were recleaned thoroughly prior to loading of the fuel oil. The audit team noted that the licensee procedure of sampling the fuel before it is loaded into the tanker and not at the off-load point would not prevent a recurrence of this incident. The licensee indicated that current procedures require monthly sampling of the fuel oil tanks for impurities except for bacteria, for which analyses are performed on a quarterly basis. The licensee also indicated that HBRSEP has no plans to add biocides to the fuel oil.

5.2.17.3 Recommendations for Subsequent License Renewal

5.2.17.3.1 Good Practices or Strengths of the AMP

A one-time inspection of small, elevated, diesel fire pump fuel oil tank and diesel generator day tanks is not warranted. These small tanks have limited access to the tank internals, making it impractical to clean and perform a meaningful inspection. UT is also considered inappropriate to detect small amounts of pitting in tanks constructed of carbon steel that is measured in units of gauge thickness (e.g., diesel fire pump fuel oil tank is made of hot rolled, 12 gauge steel). Based on operating history, external tank and structure inspections are considered sufficient to identify degradation in the tank walls.

5.2.17.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

As a result of LR review, the following enhancements were made to program: (1) Improve sampling and de-watering of selected storage tanks, (2) formalize existing practices for draining and filling diesel fuel oil storage tank periodically, (3) formalize bacteria testing for fuel oil samples from various tanks, (4) incorporate quarterly trending of fuel oil chemistry parameters.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.18 Reactor Vessel Surveillance (XI.M31)

5.2.18.1 Objective and Scope of the AMP

The licensee through the RNP Reactor Vessel Surveillance program has completed testing of four surveillance capsules, with three surveillance capsules remaining in the reactor pressure vessel (RPV). The NRC approved the delay of the Capsule U testing until the capsule achieves 38 effective full power years (EFPY) of exposure. This allows the capsule to achieve a neutron fluence that approximates that for the RPV at 80 years. Capsules W and Y were relocated during refueling outage 27 to higher fluence locations. For Capsule Z, the licensee stated that it was withdrawn in 1977 and is in storage.

5.2.18.2 Effectiveness of the AMP to Meet its Objective

5.2.18.2.1 Adequacy of the Program Description

The RNP LRA notes that its AMP B.3.11 is consistent with the associated GALL AMP XI.M31, Reactor Vessel Surveillance, with enhancement. The enhancement deals with revising RNP procedures, prior to the start of the PEO, to require surveillance test samples to be stored in lieu of optional disposal. The enhancement to RNP AMP B.3.11 was LR Commitment #22, which has been met and the relevant UFSAR sections updated (per NRC IR 2010008).

5.2.18.2.2 Effectiveness and Implementation of the AMP

The NRC staff discussed with the licensee if there were any changes to plant operation since the RNP license was renewed that could affect the vessel fluence or embrittlement. The licensee indicated there were no changes affecting these aspects of the program. The licensee also noted that the RNP surveillance program is one of the few programs with availability of capsules suitable for long-term data collection covering the subsequent license renewal period.

5.2.18.3 Recommendations for Subsequent License Renewal

5.2.18.3.1 Good Practices or Strengths of the AMP

RNP credits its Reactor Vessel Surveillance Program for aging management of the reactor vessel upper shell, intermediate shell, and lower shell, as well as the reactor vessel inlet and outlet nozzles, for the aging effect and mechanism of irradiation embrittlement resulting in a change of material properties, due to prolonged neutron exposure. RNP performs the projections of changes in material properties, in accordance with NRC RG 1.99, Rev. 2, using both methods allowed: The neutron embrittlement, using chemistry tables, and using the surveillance data, where credible, for which its program is set up to collect data during remainder of the current operating term, and during the PEO.

5.2.18.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

The withdrawal of its Capsule "U" (5th one) was scheduled just after the start of the PEO (in 2012 with 29.8 EFPY, with fluence representative of the 60-year term of the PEO). RNP submitted a change to this withdrawal schedule (ADAMS ML11276A002) postponing it to 38 EFPY. This change has been approved by the NRC (ADAMS ML11349A026). NRC should check and confirm the status of this repositioning, UFSAR update, and RNP plan for review/approval of these repositioned capsules for long term operation.

5. Monitoring and Trending:

Since the 60-year fluence data (originally from capsule U) will not be available, and the change of schedule to remove the capsule U about 11 years after the start of the PEO, RNP personnel were asked if is there any change in the basis needed or used in the RNP estimation method(s) for the 60-year projected material properties, as well as the projected fluence. The licensee was asked if there any change of frequency with which dosimetry data are monitored and/or how these are trended (projected) during the PEO.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

During the audit the staff also enquired if there were any materials, other than those considered in the beltline region of the surveillance program, for which the projected fluence (during the PEO and LTO) may reach or exceed the limit of 10^{17} n/cm^2, such as the vessel nozzle materials. RNP indicated this to be unlikely. The staff noted that any materials-related chemistry factors are reviewed separately under the relevant TLAA programs. In this connection the staff requested RNP to provide for review the latest revision of RNP-L/LR-0501 (re: Neutron Embrittlement TLAA for the RNP Reactor Vessel) and a copy of the basis document WCAP-15805. RNP indicated that these will be provided for staff's review. From Rev. 1 of RNP-L/LR-0501 (dated 2002) the staff noted that RNP's 60-year fluence was projected (calculated) based on surveillance data from its capsules V, S, and T, (a replacement capsule irradiated during its Cycle 9 operation), and its Reactor Cavity Neutron Monitoring Program (from Cycles 9 through 15). The RNP evaluation showed the beltline materials to be more limiting, relative to pressurized thermal shock (PTS) and upper shelf energy (USE), than its inlet/outlet nozzles and associated welds.

5.2.19 One-Time Inspection (XI.M32)

5.2.19.1 Objective and Scope of the AMP

The RNP AMP B.4.4 ("One-Time Inspection Program) is a new program that was created at the time of the license renewal process. The RNP LRA states that this program is consistent with GALL, Rev. 0, AMP XI, M32 ("One-Time Inspection") with no exceptions or enhancements. The LRA also states that the program was created to verify the effectiveness of existing AMPs, as well as to provide additional assurance that aging is not occurring or the aging is so insignificant that aging management is not required for the license renewal period. The AMP is credited for managing a variety of aging effects in various systems at RNP, including piping in several systems, diesel generator engine exhaust silencers, and various reactor containment system components.

5.2.19.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.19.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The LRA states that the program was created to verify the effectiveness of existing programs as well as providing additional assurance that aging is not occurring or the evidence of aging is so insignificant that an aging management is not required for the license renewal period. Program activities consist of inspecting: (1) the component cooling water heat exchanger tubes, (2) miscellaneous piping protected by the Water Chemistry Program, (3) small bore reactor coolant system and connected piping, (4) emergency diesel generator exhaust silencers, (5) containment liner plate and moisture barrier, and (6) diesel fire pump fuel oil tank, and (7) steam generator feed ring/J nozzles.

5.2.19.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M32 Program Priority for Future Audits: The On-Time Inspection Program provides valuable support in the aging management of various SSCs throughout the plant by verifying the effectiveness of other aging management programs. Therefore, this AMP is rated a Medium priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, because despite our requests, the team did not have access at this plant to the CR database Passport/Portal J. This made a thorough evaluation of the effectiveness and implementation much more difficult than at earlier AMP effectiveness audits at Ginna and NMP-1.

5.2.19.3 Recommendations for Subsequent License Renewal

5.2.19.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.19.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M32.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The Water Chemistry Program continues to be critical to the management of significant aging mechanisms in the primary and secondary systems, and industry guidance is periodically updated.

1. Scope of Program:

As noted above, the RNP LRA states that this program is consistent with GALL, Rev. 0, AMP XI, M32 ("One-Time Inspection") with no exceptions or enhancements.

No further review item identified.

2. Preventive Action:

No review item identified.

3. Parameters Monitored/Inspected:

As a part of the license renewal process, RNP committed to one-time inspections of a number of components. These inspections and the resulting observations and follow-on activities, as discussed during the audit, are listed below:

- Component cooling water heat exchanger tubing. RNP stated during the audit that the inspection had determined that some corrosion was present, and the Cu heat exchanger tubes in two heat exchangers were proactively replaced with AL-6XN tubes during refueling outage RO-25 and RO-26, even though the old tubes still had acceptable wall thickness. Based on tube wall measurements, the licensee determined that re-tubing was necessary because the predicted life of the tubing would not be acceptable during the period of extended operation. In addition, the licensee established preventive maintenance activities to perform eddy current testing for both heat exchangers on a 6-year (maximum) frequency. In addition, Preventive Maintenance (AMP B.3.18) activities have been established to perform eddy current testing for both heat exchangers on a 6-year frequency. This activity is also discussed in Section 5.2.12, XI.M21A (Closed Treated Water System).

- Miscellaneous piping in steam and power conversion systems protected by the Water Chemistry Program. A total of 21 inspections of miscellaneous piping in the steam and power conversion systems were performed in 2004 during RO-22. An additional 12 inspections were completed during RO-26 in 2010. The inspection locations were selected based on material and environments that would represent leading indicators of age-related degradation.

- The small bore reactor coolant system and connected piping to verify effectiveness of the Water Chemistry Program. Components to be examined will be selected based on accessibility, exposure levels, NDE techniques, and locations identified in NRC IN 97-46. A total of 131 small-bore piping welds were determined to be within the scope of the inspection population. Seven UT examinations of small bore piping welds were performed during RO-25 in 2008. An additional 20 examinations were completed during RO-26 in 2010. No adverse conditions were identified.

- Emergency diesel generator exhaust silencers. The component configuration made a thorough inspection difficult, but preliminary findings indicated corrosion, and the silencers were replaced.

- Certain inaccessible areas of the containment liner plate and containment structure moisture barrier behind insulation panels at the regenerative heat exchanger and refueling canal. Again, access was difficult and dose levels were high, and, since the portions of the moisture barrier showed signs of degradation, they were replaced.

- The diesel fire pump fuel oil tank. This inspection was carried out, but the details were not discussed during the audit.

- Steam Generator feed ring/J-nozzles. This inspection was carried out, but the details were not discussed during the audit.

In response to a reviewer's question concerning RNP's OpE with small-bore piping socket welds, it was stated that there had been no significant cracking problems, either from SCC or fatigue. The RNP personnel also noted the difficulties associated with UT inspections of these welds.

RNP updated the program basis document, "Aging Management Program One-Time Inspection Program," in 2004, by revising several of the attachments associated with each inspection, updating and adding several references, and revising other minor details. RNP did not make substantive changes to and did not update information in the program basis document to reflect the

results of each inspection performed by the program. The staff considered the program basis document to only be of historical value, since it did not provide any ongoing insights into the program's implementation.

No further review item identified.

4. Detection of Aging Effects:

As stated under Program Element 3 ("Parameters Monitored/Inspected") above, the one-time inspection detected degradation in some of the component cooling water heat exchanger tubing, the emergency diesel generator exhaust silencers, and the containment liner moisture barrier, and appropriate actions were taken.

No further review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

All of the one-time inspections committed to as a part of the license renewal process appear to have been carried out and the resulting observations have been addressed. No significant issues with respect to this program were identified during the audit.

Based on the staff's reviews, the AMP appeared to be effective, although some of the inspections performed under this program would not have been considered appropriate under the latest revision to the program.

The one-time inspection conducted as part of RNP license renewal found indications of aging mechanisms:

> During the audit, the NRC staff noted that the "B" component cooling water heat exchanger was re-tubed during refueling outage 25 in 2008. As a result of the inspection and based on the tube wall measurements, the licensee also re-tubed the "A" component cooling water heat exchanger during refueling outage 26 in 2010 because the predicted life of the tubing would not have been acceptable during the PEO. In addition, the licensee established preventive maintenance activities to perform eddy current testing for both heat exchangers on a 6-year (maximum) frequency.
>
> The NRC staff also noted that the results of the licensee's inspection of the emergency diesel generator exhaust silencers determined them to be acceptable. However, due to the difficulty in performing periodic inspections and preventive maintenance, the licensee established a plan to periodically replace the silencers. The NRC staff further noted that, during the inspection of inaccessible areas of the containment liner behind insulation panels at the regenerative heat exchanger and refueling canal, the licensee identified degraded portions of the moisture barrier. Also, the licensee found no degradation of the containment liner, and removed and replaced the moisture barrier at each of the insulation panels

5.2.20 Selective Leaching (XI.M33)

5.2.20.1 Objective and Scope of the AMP

The RNP AMP B.4.5 is a new program to manage loss of material due to selective leaching that was implemented at the time of license renewal. RNP SER (NUREG-1785) Commitment Item #35 specified that, prior to the period of extended operation the Selective Leaching of Materials Program will be a new program to determine the properties of selected components that may be susceptible to selective leaching. The program will ascertain whether loss of material is occurring and whether the process will affect the ability of the components to perform their intended function for the period of extended operation.

The RNP LRA describes the program as consistent with GALL AMP XI.M33 ("Selective Leaching of Materials") with one exception. This exception involves the use of mechanical means, other than Brinell hardness testing identified in the GALL Report, to identify the presence of selective leaching of material. The LRA justifies the exception on the basis that (1) hardness testing cannot be reliably performed for most components due to form and configuration and (2) other mechanical means, i.e., resonance when struck by another object, scraping, or chipping, provide an equally valid method of identification.

The RNP program for selective leaching inspects components made of cast iron, bronze, brass, and other alloys exposed to a raw water, brackish water, treated water, or groundwater environment that may lead to selective leaching of one of the metal components. The AMP includes a one-time visual inspection and mechanical testing of selected components that may be susceptible to selective leaching to determine whether loss of material due to this process is occurring, and whether this process will affect the ability of the affected components to perform their intended function for the period of extended operation.

At RNP, the Selective Leaching of Materials Program is credited for aging management of selected components in the following systems:

- Diesel Generator System
- Site Fire Protection System
- Service Water System
- Auxiliary Feedwater System

5.2.20.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.20.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

As stated above, the RNP Selective Leaching Program was initiated as a part of the license renewal process and claims to be consistent with GALL AMP XI.M33 with one exception related to the mechanical means used to detect leaching. The technical basis for this exception is clearly stated in the Program Description, and the aging effects managed and the systems and components to which the program is applied are clearly identified. The Program Description was found to be adequate and complete.

5.2.20.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M33 Program Priority for Future Audits: The Selective Leaching of Materials Program is a well-established program based on a mature technology, and the impact of the selective leaching process on the operation of plants in the U.S. has been relatively minor. Therefore, this AMP would be rated a “Low” priority for future AMP audits.

(b) In situations where selective leaching is detected, additional guidance on further sampling and the use of destructive metallography to confirm and quantify the field observations is desirable.

5.2.20.3 Recommendations for Subsequent License Renewal

5.2.20.3.1 Good Practices or Strengths of the AMP

M33.S-1: *Recommendation*: The licensee’s expansion of the sample size in response to observations of selective leaching during initial sampling is considered good practice.
Technical Basis: In May 2010, selective leaching (graphitization) to a shallow depth was identified for four cast iron valves in the service water system. The sample size was then expanded to 100% of the susceptible valves in the service water system.

5.2.20.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

M33.0-1: *Recommendation*: This AMP would be rated a Low priority for future AMP audits.
***Technical Basis*:** The Selective Leaching of Materials Program is a well-established program based on a mature technology, and the impact of the selective leaching process on the operation of plants in the U.S. has been relatively minor.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

M33.3-1: *Recommendation*: In situations where selective leaching is detected, additional guidance on further sampling and the use of destructive metallography to confirm and quantify the field observations is desirable.
***Technical Basis*:** In May 2010, selective leaching (graphitization) to a shallow depth was identified for four cast iron valves in the service water system. The selective leaching was identified by tapping with a ball peen hammer, which produced shallow indentations and, in some cases, fractured a portion internal diameter of the valve flange. Also, scraping the valve IDs with a flat bladed screwdriver was able to easily remove softened material. The sample size was then expanded to 100% of the susceptible valves in the service water system. This was identified as good practice above. However, the sample size for similar components serving under similar conditions in the fire protection system was not expanded in response to this finding, nor was destructive metallography performed on the degraded components to better quantify the depth of the leaching that had occurred. Subsequent to the audit, RNP provided documentation providing more details on the initial sampling and subsequent destructive metallography that had been carried out on components in the fire water protection system. Based on this, the reviewers concluded that the sample size for the fire water protection system piping was adequate. However, the need for destructive examinations of future components that had undergone selective leaching remained.

4. Detection of Aging Effects:

(See Recommendation M33.3-1 above concerning the use of destructive metallography to confirm and quantify field observations.)

5. Monitoring and Trending:

(See Recommendation M33.3-1 above concerning the use of destructive metallography to confirm and quantify field observations.)

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

During the one-time inspection for selective leaching (graphitization), the licensee identified degradation in four gray cast iron valve bodies in the service water system. The mechanical test used by the licensee to identify the graphitization was tapping and scraping of the surface. The licensee sand blasted two of the valve bodies and after all of the graphite was removed; the licensee determined that the leaching progressed to a depth of approximately 3/32 inch. Based on the estimated corrosion rate, the licensee determined that the valve bodies had adequate wall thickness for at least 20 years of additional service. The licensee did not perform destructive metallography or similar examinations in the service water system valves. Following this finding, the licensee sampled all susceptible valves in the service water system for selective leaching. The licensee stated that they plan to continue sampling and replacing more valves in future outages.

5.2.21 Flux Thimble Tube Inspection (XI.M37)

5.2.21.1 Objective and Scope of the AMP

The objective of this program is to manage the loss of material due to wear in the flux thimble tubes of bottom-mounted instrument systems for in-core neutron flux monitoring of PWRs. These tubes are made of cold-worked austenitic stainless steel, with or without chrome-plating, and are part of the reactor coolant system (RCS) pressure boundary. The wear of flux thimble tubes occurs at certain locations due to flow-induced vibrations which are plant-specific and the resulting wall-loss is highly location-dependent. In the case of RNP these tubes are of unique design with double-wall (inner tube and outer tube) construction.

To ensure that the aging effects due to loss of material from wear of the flux thimble tubes will be adequately managed such that their intended functional integrity is maintained during the extended and long-term operation, the AMP relies on three aging management activities: (i) periodic inspections with acceptable and qualified methods to detect and conservatively estimate the wall loss, (ii) evaluation of inspection results to determine the adequacy of inspection interval for each tube, and (iii) dispositioning of all flaws with technically justified acceptance criteria for tube failure or leakage. For these activities the AMP relies on the requirements or guidance from the NRC IE Bulletin 88-09, “Thimble Tube Thinning in Westinghouse Reactors,” July 26, 1988.

RNP LRA Section B.2.8 summarizes RNP’s Flux Thimble Eddy Current Inspection Program for incore flux thimble tubes as a plant specific program since the associated GALL Report (Rev.0, 2001) did not contain the AMP for flux thimble tubes. The LRA credits its plant specific program for aging management of incore flux thimbles for loss of material due to mechanical tube wear. There were no exceptions or enhancements, since there was no analogous AMP in GALL Rev. 0. GALL Rev. 2, has only one AMR line item in which XI.M37 was used, with cross-reference to XI.M16 (the actual AMP has no cross-reference). RNP’s LRA AMP B.2.8 is based on the licensee response to NRC Bulletin 88-09 for tube wear.

5.2.21.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.21.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be generally adequate covering the related GALL AMP in latest Rev.2 of GALL Report (NUREG-1801).

Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.21.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M37 Program Priority for Future Audits: The Flux Thimble Tube Inspection AMP is in response to the NRC IE Bulletin 88-09 that addresses the potential direct leakage of the RCS with a possibility for nonisolable leak. While the industry experience is generally good with timely detection of the tube wear the experience has shown the need for its continued management as well. Therefore, this AMP is rated a “High” priority for future AMP audits.

(b) Procedurally, RNP implementation of the XI.M37 AMP uses the ECT inspections (during RFO) acceptable per GALL Rev.2 Report and with frequency based on the plant-specific wear data. The RNP implementation includes acceptance criteria for both the inner and outer tube wall wear. These attributes are considered to make the program and its implementation at RNP to be effective.

5.2.21.3 Recommendations for Subsequent License Renewal

5.2.21.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.21.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

M37.0-1: ***Recommendation*:** This AMP is rated as a High priority for future AMP audits.
***Technical Basis*:** The primary aim of this AMP is to address the potential for a direct leakage of primary side coolant while in operation and to reduce the chance of possible unisolable breach of the RCS. Since this is a condition monitoring program and since leakage instances have continued to occur in industry even after the implementations, in general, in response to the NRC Bulletin 88-09 it is important that the AMP be evaluated periodically in order to ensure its effectiveness and timely identification aspect

1. <u>Scope of Program</u>:

M37.1-1: *Recommendation*: The scope of this AMP should be expanded to at least note other degradation mechanisms for this high-fluence component and include by reference the relevant other AMPs for managing these aging effects: SCC, IASCC, and void swelling. The related AMPs would be, e.g., the Water Chemistry Program and the Vessel Internals Program.
***Technical Basis*:** From the review of NUREG-1785 items relating to this AMP at RNP and those at Ginna LR audit, including observations from similar program reviews at other plants the flux thimble tubes are subject to aging due to cracking and irradiation mechanisms in addition to plant-specific wear. These mechanisms can accelerate the effective degradation leading to leakage especially with long term operation of the original tubes.

2. <u>Preventive Action</u>:

M37.2-1: *Recommendation*: This AMP is a condition monitoring program with no associated preventive actions to be implemented. However, based on the review of recent wear performance at RNP and the licensee's confidence in forming the basis for its relatively long inspection interval, the potential for a preventive measure in the form of double-wall design for future replacements should be explored.
***Technical Basis*:** It is possible that the double-wall design changes vibration characteristics of these tubes favorably, and provides an extra barrier for early detection of possible degradation. This could provide support for the design as a potentially preventive measure, with a technical review of these characteristics.

3. <u>Parameters Monitored/Inspected</u>:

M37.3-1: *Recommendation*: This element of the AMP should be reviewed in light of the industry OpE since original GALL report was issued to assess if parameters other than the volumetric wear be included to address other aging degradation effects.
***Technical Basis*:** The inspection program for these tubes is currently limited and focused only on tube volumetric wear, whereas other potential mechanisms including SCC, IASCC, and void swelling seem pertinent for the long term operation and given the lack of confirmatory root cause evaluations of most instances related to the flux thimble tube events in the past.

4. <u>Detection of Aging Effects</u>:

No further review item identified.

5. <u>Monitoring and Trending</u>:

During the AMP effectiveness audit interview, the licensee stated that there had been no changes made to the implementing procedures since the PEO. The licensee's letter dated April 13, 2009, related to the update on the NRC Bulletin 88-09: "Thimble Tube Thinning in Westinghouse Reactors" (ADAMS Accession No. ML091100397) stated that the frequency of eddy current inspection of the thimble tubes was being changed from every third fueling outage to every sixth refueling outage.

6. <u>Acceptance Criteria</u>:

No further review item identified.

7. <u>Corrective Actions</u>:

No further review item identified.

8. <u>Confirmation Process</u>:

No further review item identified.

9. <u>Administrative Controls</u>:

No further review item identified.

10. <u>Operating Experience</u>:

M37.10-1: *Recommendation*: In those instances where leakage during service or through-wall indication during inspection are identified, every attempt should be made to identify or confirm actual or probable root cause(s) for such degradation. This AMP should be expanded to at least note other degradation mechanisms for this high-fluence component and include by reference the other AMPs for managing these aging effects: SCC, IASCC, and void swelling. The related AMPs would be, e.g., Water Chemistry Program and Vessel Internals Program.
***Technical Basis*:** From the RNP OpE of events related to the flux thimble tubes, and several leakage instances in other plants including periods after the approvals of respective LRAs, there is little confirmation of the root cause(s). If the actual or concomitant cause is other than just the tube wear then the effectiveness of the AMP to address such aging related effect(s) will need to be addressed in the long term operation.

5.2.22 Lubricating Oil Analysis (XI.M39)

5.2.22.1 Objective and Scope of the AMP

The purpose of the Lubricating Oil Analysis program is to ensure that the oil environment in the mechanical systems is maintained to the required quality to prevent or mitigate age-related degradation of components within the scope of this program. This program maintains oil systems contaminants (primarily water and particulates) within acceptable limits, thereby preserving an environment that is not conducive to loss of material or reduction of heat transfer. Lubricating oil testing activities include sampling and analysis of lubricating oil for detrimental contaminants. The presence of water or particulates may also be indicative of in-leakage and corrosion product buildup.

Although primarily a sampling program, the lubricating oil analysis program is generally effective in monitoring and controlling impurities. This report identifies when the program is to be augmented to manage the effects of aging for license renewal. Accordingly, in certain cases identified in this report, verification of the effectiveness of the program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the PEO. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system.

5.2.22.2 Effectiveness of the AMP to Meet its Objective

The licensee implemented a Lube Oil Analysis Program, although this program is not identified in the RNP license renewal SER. The Lube Oil Analysis Program monitors for moisture, corrosion particles, and contaminants in the lubricating oil, using a combination of acceptance limits from the lubricant manufacturer recommendations and EPRI documents. There was no AMP effectiveness audit completed.

5.2.22.2.1 Adequacy of the Program Description

N/A

5.2.22.2.2 Effectiveness and Implementation of the AMP

The licensee System Health Report completed on December 2010 concluded a green finding on each parameter

5.2.22.3 Recommendations for Subsequent License Renewal

5.2.22.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.22.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.2.23 Buried and Underground Piping and Tanks (XI.M41)

5.2.23.1 Objective and Scope of the AMP

The aging of buried and underground piping and tanks is managed at RNP by two programs, namely the Buried Piping and Tanks Surveillance Program (B.3.8) and the Buried Piping and Tanks Inspection Program (B.3.12). These correspond respectively to the GALL Rev. 0 AMPs XI.M28 ("Buried Piping and Tanks Surveillance") and XI.M34 ("Buried Piping and Tanks Inspection"). The RNP program described in the RNP SER was based on opportunistic inspections of buried piping that has been uncovered; with no directed inspections of such piping. The NRC staff audited the combined program.

The Buried Piping and Tanks Surveillance Program (B.3.8) is an enhanced existing program that is credited for aging management of selected components in the Fuel Oil System with respect to loss of material due to general, crevice, and pitting corrosion as well as MIC. It relies primarily on cathodic protection to provide corrosion protection and leak testing to detect failures. Program enhancements and exceptions to GALL Rev. 0 AMP XI.M28 are discussed below in Section 5.2.23.3, Item 1 ("Scope of Program").

The Buried Piping and Tanks Inspection Program is an enhanced existing program that is credited for aging management of selected components in systems at RNP, including the Service Water System. The aging effects/mechanisms of concern are loss of material due to general, crevice, pitting, and galvanic Corrosion as well as MIC. Program enhancements and exceptions to GALL Rev. 0 AMP XI.M34 are discussed below in Section 5.2.23.3, Item 1 ("Scope of Program").

5.2.23.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.23.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The RNP Buried Piping and Tanks Surveillance Program and the Buried Piping and Tanks Inspection Program were enhanced to be consistent with the corresponding GALL Rev. 0 AMPs with the exceptions noted below in Section 5.2.23.3, Item 1, all of which were found to be acceptable during the license renewal process. Subsequent to license renewal, the two RNP AMPs have, for all intents and purposes, been merged into a single program that is consistent with GALL Rev. 2 AMP X1.M41 ("Buried Piping and Tanks"), with some exceptions discussed below. This combined RNP program is discussed here.

One good practice or strength of the AMP was identified in this review. RNP conducts routine periodic (3 year) evaluations/surveys of the cathodic protection system by an independent consultant, with plans to go to an annual inspection. The preventive maintenance has been changed to perform an annual inspection and to have a system assessment performed by annually. The

licensee monitors rectifier output levels monthly, but there appears to be no systematic trending of these data. The licensee also stated that the cathodic protection system has been fully operational since October 2012, after the replacement of two anodes was completed. The licensee informed the NRC after the audit that anode 2-A20A was found out of service on November 15, 2012, and anode 2-A2 was found out of service on January 27, 2010. Both anodes were replaced and returned to service on September 10, 2013. Rectifier-2 was found out of service on August 1, 2013, and was repaired and returned to service on August 28, 2013.

Information on possible effects of plant modifications on this AMP was not identified during this audit.

5.2.23.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) The GALL XI.M2 Program Priority for Future Audits: The Buried Piping and Tanks Program is based on mature technologies, but, as confirmed by the RNP audit, problems in implementing important aspects of the program (e.g., cathodic protection), continue to be encountered in practice. Therefore, this AMP is rated a Medium priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, since, despite our requests; the team did not have access at this plant to the CR database Passport/Portal J. This made a thorough evaluation of the effectiveness and implementation much more difficult than at earlier AMP effectiveness audits at Ginna and NMP-1. Nonetheless, some OpE with respect to this program was obtained from the RNP LRA and from system health reports and self-assessments that were available through the RNP portal.

5.2.23.3 Recommendations for Subsequent License Renewal

5.2.23.3.1 Good Practices or Strengths of the AMP

M41.S-1: *Recommendation*: RNP conducts routine periodic (3 year) evaluations/surveys of the cathodic protection system by an independent consultant, with plans to go to an annual inspection. Internal monthly checks for system operability are also performed, as well as annual soil resistivity checks. This is considered good practice, and a similar activity may be considered for inclusion as a part of Program Element 2 (“Preventive Actions”).
***Technical Basis*:** Cathodic protection systems have been shown to be subject to failures, and periodic checks of operability are desirable to maintain system effectiveness.

5.2.23.3.2 Areas of the AMP for Further Consideration/Enhancement

<u>Program Description</u>:

M41.0-1: *Recommendation*: This AMP is rated a Medium priority for future AMP audits.
***Technical Basis*:** The Buried Piping and Tanks Program is based on mature technologies, but, as demonstrated by the RNP audit, problems in implementing important aspects of the program (e.g., cathodic protection), continue to be encountered in practice. No specific items identified.

1. <u>Scope of Program</u>:

As a result of the license renewal review, Program Elements 3 ("Acceptance Criteria") and 8 ("Confirmation Process") of the RNP Buried Piping and Tanks Surveillance Program (B.3.8) were enhanced to:

- Review and update, as necessary, Cathodic Protection procedures to ensure consistency with NACE Standard RP-0169, 1996. The review should focus on Acceptance Criteria to ascertain the condition of the Cathodic Protection System.
- Install pressure taps and perform leak testing on the underground fuel oil piping from Unit 1 to the Unit 2 Diesel Fuel Oil Storage Tank and the underground piping from the Diesel Fuel Oil Storage Tank to each Emergency Diesel Generator (EDG) Day Tank in the Reactor Auxiliary Building.

With these enhancements, the AMP is described as being consistent with GALL Rev. 0 AMP XI.M28, Buried Piping and Tanks Surveillance, with the following exceptions:

- *Scope of Program:* The RNP program uses the guidance in NACE RP-01- 69-76 in lieu of the 1996 standard. The above-mentioned enhancement to review and update, as necessary, cathodic protection procedures to ensure consistency with NACE Standard RP-0169, 1996, addresses this exception.
- *Scope of Program:* There are no buried tanks in this program. The RNP Cathodic Protection System protects buried Fuel Oil System piping and the external, tank bottom surfaces of Fuel Oil System tanks in contact with the ground.
- *Scope of Program and Preventive Actions:* Aspects of underground Fuel Oil System piping relating to coatings and inspections are included within the scope of the Buried Piping and Tanks Inspection Program in lieu of this program.
- *Parameters Monitored/Inspected:* No documentation of initial coating conductance is available. In-situ measurement of coating conductance is not considered prudent due to the potential to cause coating damage during excavation and measurement, changing the local soil electrolytic conditions, or stressing the coatings due to changes in the local conditions of the supporting soil.
- *Acceptance Criteria:* The Buried Piping and Tanks Inspection Program, in lieu of this program, is used to determine the condition of pipe coatings when piping is exposed for any reason.

The RNP Buried Piping and Tanks Inspection Program (B.3.12) was similarly enhanced as a result of the license renewal review with respect to Program Elements 3 ("Parameters Monitored/Inspected') and 6 ("Acceptance Criteria") as follows:

- Incorporate a requirement to ensure an appropriate as-found pipe coating and material condition inspection is performed whenever buried piping within the scope of this program is exposed.
- Add precautions to ensure backfill with material that is free of gravel or other sharp or hard material that can damage the coating.
- Add a requirement that coating inspections be performed by qualified personnel to assess coating condition.
- Add a requirement that a coating engineer should assist in evaluation of any coating degradation noted during the Inspection.

The RNP Buried Piping and Tanks Inspection Program is stated to be consistent with GALL Rev. 0 AMP XI.M34 ("Buried Piping and Tanks Inspection") with the following exceptions, all of which impact Program Element 1, Scope of Program.

- The Program contains no buried tanks.
- The Program includes additional components, i.e., underground Fuel Oil System piping, within the scope of the Buried Piping and Tanks Surveillance Program.
- In addition to carbon steel components, buried cast iron piping and fittings are included in the Program.
- The Program includes galvanic corrosion as a potential aging mechanism.

RNP-2 performed a gap analysis between their AMPs based on GALL Rev. 0 and GALL Rev. 2 AMP XI.M41. Conclusions of the gap analysis include:

- GALL Rev. 0 AMP XI.M34 requires only opportunistic inspections, while GALL Rev. 2 AMP XI.M41 also specifies directed inspections. In response, RNP has performed a limited number of directed inspections, one of which identified a leak in a potable water line under a roadway, possibly related to rocks in the backfill. A subsequent directed inspection was performed on underground fire protection piping with similar backfill and no problems were identified.
- GALL Rev. 2 AMP XI.M41 increases the number of materials covered over what was in GALL Rev. 0 AMPs XI.M28 and XI.M34. RNP AMP procedure is consistent with industry Nuclear Strategic Issues Advisory Committee (NSIAC) initiative and NEI 09-14. The intent of GALL Rev. 2 AMP XI.M41 will be met by the implementation of this corporate procedure.

No further review item identified.

2. Preventive Action:

Depending on the piping material, preventive and mitigative techniques employed at RNP may include monitoring the condition of external coatings for external corrosion control, the application of cathodic protection, and the monitoring the quality of backfill used. As noted above, RNP AMP B.3.12 was enhanced to ensure that an appropriate as-found pipe coating and material condition inspection is performed whenever buried piping within the scope of this program is exposed and that coating inspections be performed by qualified personnel. An additional enhancement added precautions to ensure that backfill is free of gravel or other sharp or hard material that can damage the coating.

However, the remaining preventive measure, cathodic protection, has been a significant source of problems at RNP over the years, including the following:

- In a 1991 inspection, the NRC determined that the cathodic protection system was known to have been operating outside of its original specification. The NRC found that only about 7 years of cathodic protection could be assured following the system's installation in 1981. Degradation of the system in 1988 appeared to have been caused by installation of concrete in the yard. Closure of this concern was based on an inspection of emergency diesel generator fuel oil underground piping that demonstrated the piping coating was intact with no detectable piping degradation.

- In 1996 and 2001, RNP assessed anomalies in data recorded during the monitoring of the cathodic protection system. The assessments recommended corrective action be taken to repair the system. Nevertheless, RNP concluded that the as-found condition for substantial portions of the buried fuel piping indicated they had “some level” of cathodic protection prior to system repairs.
- In 2008, the CORRPRO Company performed a Cathodic Protection System assessment for RNP. This assessment determined that the Cathodic Protection System was operating in a degraded condition and required the installation of additional anodes to bring the system up to NACE Standards. In October 2009, RNP procedure “Cathodic Protection System Improvements” was completed to incorporate the 2008 recommendations of the CORRPRO assessment report.
- The RNP Buried Piping Self Assessment for the third quarter of 2011 stated that a portion of the cathodic protection system for the emergency diesel generator buried piping had been inoperable for over one year, and portions of the system had been inoperable numerous times since a similar finding several years previously. The NRC staff reviewed this self-assessment which stated that the program was not meeting expectations. The licensee stated that the deficiencies cited in this self-assessment were addressed with new personnel and updated procedures, and the specific condition reports mentioned in this self-assessment are closed.
- The RNP-2 Program Health report for the 3rd quarter 2012, stated the cathodic protection system was providing a level of protection for the buried diesel fuel oil lines. However, a lack of priority for repair of the system has resulted in extended periods where portions of the system were not functioning properly. There are no indications of degraded piping supported by the system. However, the system was installed to provide a safety barrier, and is expected to function properly. The report further stated the system has currently been restored. It went on to state that sufficient priority should be given to maintenance of the system, considering the potential impact to the condition of the piping and the implementation of the Buried Piping Program.

In response, RNP stated during the audit that the problems identified in the 1991, 1996, and 2001 reports had been corrected prior to license renewal in 2004, as borne out by the SER (NUREG-1785), and the CORRPRO recommendations of 2008 to install additional anodes had been completed. They also stated that the self-assessment of 2011 applied largely to RNP Unit 1, an adjacent fossil-fueled generating plant and that Unit 2 had “always” been protected “with some exceptions.” Presumably, this refers to the statement in this report that the cathodic protection system for the emergency diesel generator buried piping has been inoperable for over one year. In addition, RNP personnel stated that the deficiencies cited in the 2011 self-assessment were being actively addressed with new personnel and updated procedures. They added that the specific condition reports mentioned in this self-assessment had been satisfactorily closed out, and that, as of October 2012, the system was fully functional.

M41.2-1: *Recommendation*: More detail on how RNP addressed the deficiencies cited in the 2008 and 2011 assessments would be helpful, particularly since similar problems with the cathodic protection systems at several other plants, including Indian Point 2 (ML101760345), Clinton (EA-96-412), South Texas 1 and 2 (ML112800109), Seabrook (ML111360432), and Fermi 2 (ML112991353).

***Technical Basis*:** The chronic problems with the cathodic protection system at RNP over the years are a source of concern. The history of this system has been characterized by numerous failures and repairs, only to have new problems surface. Similar problems at other plants suggest that this may be a generic problem area.

3. Parameters Monitored/Inspected:

RNP conducts routine periodic (3 year) evaluations/surveys of the CP system by an independent consultant to identify repetitive system concerns, with plans to go to an annual inspection. Internal monthly checks for cathodic protection system operability are performed, as well as annual soil resistivity checks in the vicinity of piping, some of which was out of scope. The data from these system evaluations are compared to the acceptance criteria. This activity was recognized as good practice in Section 5.2.23.3, Item M41.S-1 above. However, it appears that the data from these system evaluations are not trended. The most recent soil resistivity samples have not been analyzed yet.

The licensee performed soil survey testing to assess soil corrosion. The licensee took samples in the vicinity of buried and underground piping. At the time of the audit, the samples had not been analyzed. As part of an effort to bring the AMP into alignment with the GALL Report Revision 2, the licensee completed directed inspections of underground piping as well as opportunistic inspections. One of the directed inspections identified a leak in a potable water line under a roadway, possibly related to rocks in the backfill. The licensee performed a similar inspection on underground fire protection piping with similar backfill and no problems were identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

As stated under Program Element 3 above, RNP conducts routine periodic (3 year) evaluations/surveys of the CP system by an independent consultant to identify repetitive system concerns, with plans to go to an annual inspection. Internal monthly checks for cathodic protection system operability are performed, as well as annual soil resistivity checks in the vicinity of piping, some of which was out of scope. However, it appears that the data from these system evaluations are not trended. The most recent soil resistivity samples had not been analyzed yet at time of audit.

No further review item identified.

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. <u>Operating Experience</u>:

The RNP OpE with respect to the cathodic protection system has been described under Program Element 2 above.

The early OpE for RNP indicates numerous leaks in service water piping (LERs 83-003-00, 83-022-00, 83-029-00, and 92-015-00), but none of these involved underground potions of the piping. The RNP LRA states under the program description for AMP B.3.12 that leaks have occurred in the North Service Water header in pipe that was installed in 1984. The leaks were identified in July 1995 and in March and September 1998 and were repaired. A root cause evaluation concluded that the root cause of the July 1995 leak was damage from misoperation of a backhoe during initial installation of the piping. The root cause of the March and September 1998 leaks was improper installation of the Tapecoat external wrapping.

The LRA OpE goes on to state that other buried pipe on site has not exhibited exterior corrosion such as experienced on the North Service Water header. The original service water piping has the same type of coating used in the North Service Water header but has not exhibited a similar tendency to leak. The reason for this is the assumption that the coating, when properly installed and not damaged, effectively prevents external degradation.

More recently, RNP has performed a limited number of directed inspections, one of which identified a leak in a potable water line under a roadway, possibly related to rocks in the backfill.

M41.10-1: *Recommendation*: see M41.2-1 recommendation above.

5.2.24 Fatigue Monitoring (TLAA X.M1)

5.2.24.1 Objective and Scope of the AMP

The B.3.19 Metal Fatigue of Reactor Coolant Pressure Boundary Program manages cracking due to fatigue for the reactor coolant pressure boundary components and specified secondary side components by monitoring the design transient cycles to assure that transient limits are not exceeded for the components. The program is an existing program that has been enhanced to manage the aging effect/mechanism of thermal fatigue of select components in various NSSS and secondary systems, by monitoring the number of transients postulated in the fatigue design. The number of transients is monitored and evaluated and corrective action is taken when the value is within 10% of the design limit. This program also includes fatigue usage calculations considering environmental fatigue effects for each of the locations identified in NUREG/CR-6260 and for additional locations.

In the original plant design, explicit fatigue analyses were performed in accordance with ASME Section III for the reactor vessel, pressurizer, steam generators, and the reactor coolant pumps. Later, additional transients were added for surge line thermal stratification and pressurizer insurge and outsurge flow, reactor vessel internals, and thermal cycling of auxiliary feedwater to main feedwater (AFW/FW) connections. Explicit fatigue analyses are performed in accordance with ASME Section III Class 1 requirements; these analyses require that the fatigue cumulative usage factor (CUF) for the components remain below 1.0.

In addition, implicit fatigue analyses were performed for (a) the reactor coolant system (RCS) piping and components designed in accordance with ANSI B31.1 Code, and (b) auxiliary heat exchangers designed in accordance with Westinghouse specifications G-676454 and ASME Section III, Class C, or ASME Section VIII requirements. These design codes required consideration of cyclic loading but did not require formal fatigue analysis. Stress range reduction factors are imposed to allow for specified number of cyclic loadings, which effectively reduces the allowable stress amplitude and thereby mitigate fatigue damage to the component.

However, the fatigue usage calculations are not periodically updated, but are revised only when changes to design input assumptions are made, such as a change to the postulated number or type of transients. The program includes the following enhancement: the environmental-fatigue evaluations for the pressurizer spray nozzle safe end are performed using a reduced number of load/unload transients and a lower number of postulated transients are used in the reanalysis of AFW/FW piping connections.

For license renewal, the number of transients experienced to-date was trended, and the 60-y transient projections were shown not to exceed the 40-y transient limits. The effect of reactor coolant environment on fatigue life was also evaluated for the following seven locations: (i) RPV shell at the core support pads, (ii) RPV outlet nozzle, (iii) RPV inlet nozzle, (iv) pressurizer surge line, (v) charging nozzle, (vi) safety injection nozzle, and (vii) RHR tee. The first four were performed in accordance with ASME Section III and the others in accordance with USAS B31.1 design requirements. The environmental fatigue reduction factors (F_{en}) were computed in accordance with EPRI TR-105759, which follows the guidance of NRC documents NUREG/CR-6583 for carbon steels and NUREG/CR-5704 for austenitic stainless steels.

With the exception for the pressurizer surge line and adjacent stainless steel nozzle and safe end components, the analyses showed that the environmentally adjusted CUF values remain below 1.0 for 60 years. However, the 50-y projected CUF for the AFW/FW nozzles is 0.98. These nozzles are more limiting than the pressurizer surge line safe end, and will be replaced during the next outage.

5.2.24.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.24.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

(a) Provide specific guidance for managing the effects of metal fatigue of reactor components in accordance with the requirements of 10 CFR 54.21(c)(iii). In particular, clarify whether the GALL AMP X.M1 endorses a program on a generic basis that allows for ASME Section XI inspections in lieu of meeting the fatigue usage criteria.

(b) Provide guidance for establishing a CUF threshold for initiating planning activities for corrective action when it cannot be demonstrated that the CUF value at any location that are being monitored can be maintained below the fatigue limit of 1.0..

5.2.24.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

(a) Clarify that all design transients used in the fatigue design analyses need to be monitored by the licensee's AMP B.3.19 and not just those transients that have a "significant" contribution to fatigue usage, and that adequate justification is provided if certain transients are not monitored.

(b) Include guidance for licensees that use the 54.21(c)(1)(iii) option and propose an inspection program to manage fatigue CUF TLAAs. If the applicant has opted to use an augmented inspection program to manage the effects of fatigue during the renewal period, the LRA should describe the inspection technique, qualification, and the scope and frequency of the program. In addition, the applicant should include the following details in the application:

(i) The location where the fatigue CUF could not be shown to be less than the design limit, and that the location is accessible for inspection.
(ii) The inspection interval was justified by performing a flaw tolerance analysis using approved, environmentally adjusted crack growth rates and loss of fracture toughness of associated welds or cast austenitic stainless steel material.
(iii) Before the period of extended operation, the augmented inspection program should be submitted to the NRC for review and approval.

5.2.24.3 Recommendations for Subsequent License Renewal

5.2.24.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.2.24.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

X.M1.0-1: *Recommendation*: Revise the program description to provide specific guidance for managing the effects of metal fatigue of reactor components in accordance with the requirements of 10 CFR 54.21(c)(iii). In particular, clarify whether the GALL AMP X.M1 endorses a program on a generic basis that allows for ASME Section XI inspections in lieu of meeting the fatigue usage criteria.
***Technical Basis*:** The RNP LRA states that the environmentally adjusted fatigue CUFs for the pressurizer surge line and the adjacent stainless steel spray nozzle and safe end could not be shown to be less than 1.0 using the projected number of transients for 60 years. In addition, the applicant's program basis document indicated that the estimated CUF for a 50-year operation for the AFW/FW pipe connections was 0.986. The LRA further stated that the effects of fatigue for these locations would be managed using one or more of the following options:
(i) Further refinement of the fatigue analyses to maintain the environmentally adjusted fatigue CUF below 1.0.
(ii) Repair of the affected locations.
(iii) Replacement of the affected locations.
(iv) Management of the effects of fatigue using an augmented inspection program that has been reviewed and approved by the NRC.

However, the license renewal SRP Section 4.3.2.1.1.3 states that in GALL Chapter X.M1, the staff has evaluated a program for monitoring and tracking the number of critical thermal and pressure transients for the selected components. The SRP further states that the staff has determined that the GALL AMP X.M1 is an acceptable AMP to address metal fatigue of the reactor coolant system components according to 10 CFR 54.21(c)(iii). The GALL AMP X.M1 does not endorse a program on a generic basis that allows for ASME Section XI inspections in lieu of meeting the fatigue usage criteria. The program description should be revised to clarify

whether augmented inspection without demonstrating CUF <1.0 is an acceptable program to address metal fatigue in accordance with 10 CFR 54.21(c)(iii), or that such an option will be reviewed on a case-by-case basis.

X.M1.0-2: *Recommendation*: Revise the program description to provide specific guidance for establishing a CUF threshold for initiating planning activities for corrective action when it cannot be demonstrated that the CUF value at any location that are being monitored can be maintained below the fatigue limit of 1.0.
***Technical Basis*:** The RNP LRA states that the effects of fatigue for fatigue sensitive locations would be managed using one or more of the following options:
(i) Further refinement of the fatigue analyses to maintain the environmentally adjusted fatigue CUF below 1.0.
(ii) Repair of the affected locations.
(iii) Replacement of the affected locations.
(iv) Management of the effects of fatigue using an augmented inspection program that has been reviewed and approved by the NRC.

However, the RNP LRA or the GALL AMP X.M1 does not provide a specific CUF threshold for initiating these corrective actions. The program description of the GALL AMP X.M1 should be revised to include such information.

1. <u>Scope of Program</u>:

No further review items were identified.

2. <u>Preventive Action</u>:

No further review items were identified.

3. <u>Parameters Monitored/Inspected</u>:

X.M1.3-1: *Recommendation*: Revise the parameters monitored/inspected program element to clearly specify that all design transients used in the fatigue design analyses need to be monitored by the licensee's AMP B.3.19 and not just those transients that have a "significant" contribution to fatigue usage, and that adequate justification is provided if certain transients are not monitored.
***Technical Basis*:** The applicant's program basis document states that the RNP AMP B.3.19 "Metal Fatigue of Reactor Coolant Pressure Boundary Program" includes a review of the design transients used in the fatigue design analyses to determine which ones have a significant contribution to fatigue usage for one or more reactor coolant pressure boundary components. These transients are monitored by the RMP B.3.19 AMP, and their total number is considered to provide leading indicator of plant operation, which permits timely preventive action to assure that the limits are not exceeded.

However, regarding the licensee's transient monitoring program, the program should monitor all transients that are used in the fatigue calculations and not just those transients that have a "significant" contribution to fatigue usage. Else, adequate justification should be provided if certain transients are not monitored.

4. <u>Detection of Aging Effects</u>:

X.M1.4-1: *Recommendation*: Revise the detection of aging effects program element to provide specific guidance for managing the effects of metal fatigue of reactor components in accordance with the requirements of 10 CFR 54.21(c)(iii).
***Technical Basis*:** The RNP LRA states that the environmentally adjusted fatigue CUFs for a few reactor coolant pressure boundary components could not be shown to be less than 1.0 using the projected number of transients for 60 years. The LRA further added that the effects of fatigue for these locations would be managed using one or more of the following options:
(i) Further refinement of the fatigue analyses to maintain the environmentally adjusted fatigue CUF below 1.0.
(ii) Repair of the affected locations.
(iii) Replacement of the affected locations.
(iv) Management of the effects of fatigue using an augmented inspection program that has been reviewed and approved by the NRC.

However, as discussed earlier in recommendation X.M1-0-1, the GALL AMP X.M1 does not endorse a program on a generic basis that allows for ASME Section XI inspections in lieu of meeting the fatigue usage criteria. With continued operation up to 80 years, the environmentally adjusted fatigue CUF is likely to exceed the allowable design limit for several components, and licensees are likely to opt for the 10 CFR 54.21(c)(1)(iii) aging management option and propose an inspection program to manage fatigue damage. However, Program Elements 4, "Detection of Aging Effects" does not provide any guidance as to what is considered as an acceptable program. Program element 4 should be revised to clarify whether augmented inspection without demonstrating CUF <1.0 is an acceptable program to address metal fatigue in accordance with 10 CFR 54.21(c)(iii), or that such an option will be reviewed on a case-by-case basis.

5. <u>Monitoring and Trending</u>:

X.M1.6-1: *Recommendation*: Revise acceptance criteria program element to clarify that all design transients used in the fatigue design analyses need to be monitored by the fatigue monitoring program and not just those transients that have a "significant" contribution to fatigue usage.
***Technical Basis*:** The applicant's program basis document states that the RNP AMP B.3.19 includes a review of the design transients used in the fatigue design analyses to determine which ones have a significant contribution to fatigue usage and that these transients are monitored by the RNP fatigue monitoring program B.3.19. However, as discussed above in recommendation X.M1.3-1, the licensee's fatigue monitoring program should monitor all transients that are used in the fatigue calculations and not just those transients that have a "significant" contribution to fatigue usage. Else, adequate justification should be provided if certain transients are not monitored.

6. <u>Acceptance Criteria</u>:

X.M1.6-1: *Recommendation*: Revise acceptance criteria program element to provide specific guidance for establishing a CUF threshold for initiating planning activities for corrective action when it cannot be demonstrated that the CUF value at any location that are being monitored can be maintained below the fatigue limit of 1.0.
***Technical Basis*:** The RNP LRA states that the effects of fatigue for fatigue sensitive locations would be managed using one or more of the following options:
(i) Further refinement of the fatigue analyses to maintain the environmentally adjusted fatigue CUF below 1.0.
(ii) Repair of the affected locations.
(iii) Replacement of the affected locations.
(iv) Management of the effects of fatigue using an augmented inspection program that has been reviewed and approved by the NRC.

However, as discussed above in recommendation X.M1.0-2, the RNP LRA or the GALL AMP X.M1 does not provide a specific CUF threshold for initiating these corrective actions. Program element 6 of the GALL AMP X.M1 should be revised to include such information.

7. <u>Corrective Actions</u>:

Corrective action, include the following options:

- Further refinement of the fatigue analyses to maintain the EAF-adjusted CUF below 1.0
- Repair of the affected locations
- Replacement of the affected locations
- Management of the effects of fatigue by through the use of an augmented inspection program reviewed and approved by the NRC

In 1972, the applicant reported leakage, attributed to thermal fatigue cracking, at the 4”x16” connection between the AFW and main FW lines upstream of steam generator B. The AFW/FW connection was replaced with thermal-sleeved tees designed to ASME Section III, Subsection NB requirements, and the 40-year as well as 60-year CUF for the branch connection reinforcement plate was shown to be less than 1.0. During the LRA review, RNP stated that the three non-standard branch connections downstream from the motor-driven pumps were replaced with a standard design employing a thermal sleeve. The fatigue CUF for the other three non-standard connections downstream from the steam-driven pumps that were not replaced is expected to exceed the limit after approximately 50-year operation (i.e., July 2020). These connections will be replaced during the next outage.

X.M1.7-1: *Recommendation*: Revise the corrective action program element to include guidance for licensees that use the 54.21(c)(1)(iii) option and propose an inspection program to manage fatigue CUF TLAAs.
***Technical Basis*:** With continued operation, the fatigue CUF projected to 80-year operation and including environmental effects is likely to exceed the allowable design limit for several components, particularly PWR components. Consequently, licensees are likely

to opt for the 10 CFR 54.21(c)(1) (iii) option to disposition fatigue TLAAs with high CUF values. If the applicant has opted to use an augmented inspection program to manage the effects of fatigue during the renewal period, the LRA should describe the inspection technique, qualification, and the scope and frequency of the program. In addition, the applicant should include the following details in the application:
(a) The location where the fatigue CUF could not be shown to be less than the design limit, and that the location is accessible for inspection.
(b) The inspection interval was justified by performing a flaw tolerance analysis using approved, environmentally adjusted crack growth rates and loss of fracture toughness of associated welds or cast austenitic stainless steel material.
(c) Before the period of extended operation, the augmented inspection program should be submitted to the NRC for review and approval.

8. Confirmation Process:

No further review items were identified.

9. Administrative Controls:

No further review items were identified.

10. Operating Experience:

As part of the fatigue cycle monitoring in this program, the licensee analyzed the CUF for the auxiliary feedwater pump discharge tie-ins to the main feedwater lines. The licensee indicated that the RNP's fatigue cycle analysis estimated the CUF for these auxiliary feedwater connections is 0.98608 for 50 years of operation. In order to ensure that the CUF for these connections does not exceed the design limit, the licensee issued a work order to conduct replacement of these connections during the fall 2013 refueling outage 28. The licensee indicated that its Fatigue Monitoring Program would continue to monitor the transient cycles and CUF values for these components for adequate aging management.

Industry OpE was used in selecting the NUREG/CR- 6260 locations evaluated for environmental fatigue; pressurizer locations were included in the evaluations.

5.2.25 Systems Monitoring Program (B.3.17, Plant-Specific)

5.2.25.1 Objective and Scope of the AMP

The licensee indicated that the current RNP Systems Monitoring Program (plant-specific counterpart to AMP XI.M36, is significantly improved from the program that RNP had in place in the 1990's prior to license renewal. In particular, the program has improved in terms of program procedures, record-keeping, and data monitoring and trending. Also, the licensee maintains a comprehensive electronic database to track component conditions with time. AMP B.3.17 has enhancements credited for aging management of selected SSC with respect to the following aging effects:

- Loss of material due to general crevice, pitting, and galvanic corrosion and MIC,
- Cracking due to SCC
- Change in material properties and cracking due to elevated temperatures
- Loss of heat transfer effectiveness due to fouling of heat transfer surfaces
- Change in material properties and cracking due to irradiation embrittlement
- Loss of Material due to aggressive chemical attack
- Loss of mechanical closure integrity due to LOM due to aggressive chemical attack.

The program appears to complement the RNP Preventive Maintenance Program (B.3.18) in terms of aging effects managed, but the present program is a condition-monitoring limited to visual inspections and includes no preventive or remedial actions. The program is based on scheduled system walkdowns, system health reports, and performance monitoring and trending of systems.

The LRA states that the current systems monitoring procedures do not specifically describe the aging effects identified in the AMRs, and the following enhancements were made to the program as a part of the license renewal process:

- include aging effects identified in the aging management reviews
- identify inspection criteria in checklist form
- include guidance for inspecting connected piping/components
- require documenting identified degradation and initiating appropriate corrective action(s)
- add a section specifically addressing corrective actions

The RNP Systems Monitoring Program is similar to GALL, Rev. 2 AMP XI.M36 ("External Surfaces Monitoring of Mechanical Components") but it does not involve the physical manipulation of polymer components (see Program Element 4 below) and it does not take credit for the aging management of internal components with a similar external environment as the GALL, Rev. 2 program does.

5.2.25.2 Effectiveness of the AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to RNP were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.2.25.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of the assessment of the adequacy of the program description are as follows:

The program description was found to be somewhat vague in terms of the SSCs managed by the program. In the LRA, the applicant states that the purpose of the Systems Monitoring Program is to manage aging for selected components in the various plant systems at RNP. However, it does not identify the components and the applicable plant systems in detail. The systems and components to which the program is applied were clarified to a considerable extent during the audit.

As stated in the LRA and verified during the present audit, the administrative controls for the Program were enhanced to:

- Include aging effects identified in the aging management reviews,
- Identify inspection criteria in checklist form,
- Include guidance for inspecting connected piping/components,
- Require documenting identified degradation and initiating appropriate corrective action(s), and
- Add a section specifically addressing corrective actions.

5.2.25.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation follows:

(a) The Systems Monitoring Program Priority for Future Audits: Inspection and monitoring activities under the present plant-specific program and under similar programs related to GALL AMP XI.M36 (”External Surfaces Monitoring of Mechanical Components”) continue to be important in maintaining the reliability of a number of plant systems. Therefore, this AMP is rated a Medium priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, since despite our requests the team did not have access at this plant to the CR database Passport/Portal J. This made a thorough evaluation of the effectiveness and implementation much more difficult than at earlier AMP effectiveness audits at Ginna and NMP-1.

5.2.25.3 Recommendations for Subsequent License Renewal

5.2.25.3.1 Good Practices or Strengths of the AMP

B3.17.S-1: *Recommendation*: The licensee's monitoring and trending activities are considered a good practice or strength for effective implementation of the program and should be continued.
***Technical Basis*:** RNP personnel stated during the audit that, as a part of the present program, a comprehensive electronic data base is maintained to track component conditions with time. This is considered to be a good practice.

5.2.25.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

B3.17.1-1: *Recommendation*: Clearly indicate in the Scope of Program that seismic continuity piping is within the scope of license renewal and therefore within the scope of the present AMP.
Technical Basis: The RNP program procedure "System Walkdown Procedure" states that the seismic continuity piping segments "are in the scope of license renewal and are subject to system walkdown requirements." The RNP program evaluation document defines "seismic continuity piping" as the non-safety related piping segment that "extends beyond safety related license renewal boundaries" and is relied upon to anchor safety related piping in establishing seismic qualification. However, during the audit, RNP clarified that the seismic continuity piping in question is, in fact, within the scope of license renewal.

2. Preventive Action:

No review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

B3.17.4-1: *Recommendation*: Permit contact with and manual manipulation of polymeric materials as a means of monitoring for potential aging-related degradation.
Technical Basis: GALL, Rev. 2 AMP XI.M36 ("External Surfaces Monitoring Program") states that the aging effects of flexible polymeric components may be monitored through a combination of manipulation of the material by means of touching, pressing on, flexing, bending, or otherwise manually interacting with the material.

Among the aging effects managed by the RNP Systems Monitoring Program is the degradation of flexible polymeric materials (e.g., hardening and cracking and wear). The RNP Systems Monitoring Program limits the inspection of polymeric materials to visual

inspection and specifically rules out any operation, manipulation, agitation, or contact of plant equipment. It was stated that this was done to assure that no damage was done to the equipment. According to RNP procedures, under no circumstances should individuals performing walkdown evaluations under this program operate, manipulate, agitate, or contact plant equipment. However, as recommended in the GALL report the aging effects of flexible polymeric components may be monitored through a combination of manipulation of the material. Therefore, AMP XI.M36 should clarify to allow for manual manipulation of polymeric materials.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No review item identified.

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

No further review item identified.

5.2.26 Preventive Maintenance Program (Plant-Specific)

5.2.26.1 Objective and Scope of the AMP

The RNP AMP B.3.18 is an existing plant-specific program that is credited for aging management of selected components in the various plant systems at RNP. The purpose of the Preventive Maintenance Program is to prevent or minimize equipment breakdown and to maintain equipment in a satisfactory condition for normal and/or emergency use. The program consists of periodic inspections, test, and component replacement as necessary to manage various aging effects/mechanisms, including changes in material properties, cracking, loss of material, loss of bolting preload due to stress relaxation, reduced insulation resistance due to thermal embrittlement, and loss of heat transfer due to fouling.
The Preventive Maintenance Program is credited for aging management of selected components in the following systems at RNP:

- Reactor Coolant System
- Steam Generator
- Feedwater System
- Auxiliary Feedwater System
- Condensate System
- Component/Closed Cooling Water System
- Diesel Generator System
- Dedicated Shutdown Diesel System
- Fuel Oil System
- SEOF/TSC Security Diesel Generator System
- Instrument Air System
- Site Fire Protection System
- Potable Water System
- Primary and Demineralized Water Make-up System
- Liquid Waste Processing System
- HVAC Containment Building System
- Isolation Valve Seal Water System
- HVAC Auxiliary Building
- HVAC Control Room Area
- Reactor Auxiliary Building

The aging effects/mechanisms of concern are as follows:

- Change in Material Properties due to Elevated Temperature
- Change in Material Properties due to Irradiation Embrittlement

- Change in Material Properties due to Ultraviolet Radiation and Ozone Exposure
- Change in Material Properties due to Various Degradation Mechanisms
- Cracking due to Elevated Temperature
- Cracking due to Irradiation Embrittlement
- Cracking due to SCC
- Cracking due to Thermal Fatigue
- Cracking due to Ultraviolet Radiation and Ozone Exposure
- Cracking due to Various Degradation Mechanisms
- Loss of Material due to Crevice Corrosion
- Loss of Material due to Erosion
- Loss of Material due to FAC
- Loss of Material due to Galvanic Corrosion
- Loss of Material due to General Corrosion
- Loss of Material due to MIC
- Loss of Material due to Pitting Corrosion
- Loss of Material due to Various Degradation Mechanisms
- Loss of Pre-load due to Stress Relaxation
- Loss of Material due to Aggressive Chemical Attack
- Loss of Heat Transfer due to Fouling of Heat Transfer Surfaces
- Flow Blockage due to Fouling
- Loss of Material due to Flaking
- Loss of Material due to Selective Leaching

The Preventive Maintenance Program includes periodic refurbishment or replacement of components, which could be considered to be preventive or mitigative actions. The inspections and testing activities used to identify component aging degradation effects do not constitute preventive actions in the context of this element.

5.2.26.2 Effectiveness of the AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to RNP were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for SLR. The potential areas for further consideration are classified in the program description and the ten program elements of the AMP. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, their technical basis, and the related section in the GALL Report and/or SRP are also described.

5.2.26.2.1 Adequacy of the Program Description

The program description was found to be satisfactory. In the LRA, the applicant states that the purpose of the Preventive Maintenance Program is to assure that various aging effects are managed for a wide range of components. These components, the associated systems, and the aging degradation mechanisms managed are spelled out in detail in the AMP description. As stated in the LRA and verified during the present audit, the scope of the program was enhanced to incorporate specific aging management activities into the program that were identified in the license renewal aging management reviews. These included a number of additional inspection activities as well as additional cleaning, replacement, and refurbishment activities.

5.2.26.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation follows:

(a) The Preventive Maintenance Program Priority for Future Audits: inspection, monitoring, and preventive maintenance activities under the present plant-specific program and under similar programs related to GALL AMP XI.M36 (”External Surfaces Monitoring of Mechanical Components”) continue to be important in maintaining the reliability of a number of plant systems. Therefore, this AMP is rated a Medium priority for future AMP audits.

(b) It was difficult for the auditors to do an independent search of OpE, since, despite our requests the plant CR database was not available for review. This made an evaluation of the effectiveness and implementation of the AMPs much more difficult than at earlier effectiveness audits at Ginna and NMP-1.

5.2.26.3 Recommendations for Subsequent License Renewal

5.2.26.3.1 Good Practices or Strengths of the AMP

B3.18.S-1: ***Recommendation*****:** The licensee’s monitoring and trending activities are considered a good practice for effective implementation of the program and should be continued.
Technical Basis**:** RNP personnel stated during the audit that data from walkdowns are trended and evaluated to identify and correct problems. This is considered a good practice.

5.2.26.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No review item identified.

5. Monitoring and Trending:

No further review item identified.

6. Acceptance Criteria:

No review item identified.

7. Corrective Actions:

No review item identified.

8. Confirmation Process:

No review item identified.

9. Administrative Controls:

No review item identified.

10. Operating Experience:

B3.18.10-1: *Recommendation*: Verify that recommendations contained in RNP Self-Assessment concerning the PMP have been thoroughly and completely implemented.
Technical Basis: The RNP November 2012 Self-Assessment cited numerous deficiencies in the Preventive Maintenance Program and recommended remedial actions. The Self-Assessment included the following observation concerning the LR commitments for the Preventive Maintenance Program: "The commitments within the preventive maintenance program are properly implemented and designated as committed items. Because these activities span approximately 44 systems, there is no one point of ownership for the results of the preventive maintenance activities that are performed. This may result in missed opportunities to identify aging effects across system boundaries. It is recommended that a recurring task be assigned to the LR program engineer to periodically review completed preventive maintenance activities that are credited for license renewal." Therefore, the RNP PMP should be reviewed prior to SLR to verify that the recommended remedial actions have been completed and that the program is being effectively implemented.

5.3 AMPs for Structures

5.3.1 ASME Section XI, Subsection IWE (XI.S1)

5.3.1.1 Objective and Scope of the AMP

The RNP AMP B3.13, “ASME Section XI, Subsections IWE” is an existing program that implements GALL Report AMP XI.S1 ASME Section XI, Subsection IWE. The program consists of periodic visual, surface, and volumetric inspection of steel containment components for signs of degradation, assessment of damage, and corrective actions. The program has two enhancements that include (1) specify the requirements for conducting reexaminations, and (2) document the repairs that meet the specified acceptance standards. The program and the RNP 10 CFR 50 Appendix J Program manage aging effects of the containment pressure boundary components.

5.3.1.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.1.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. RNP IWE Program was developed based upon guidance provided in ASME Section XI, Subsection IWE. The staff determined during the audit that the overall program meets the requirements of GALL Rev. 2 AMP XI.S1.

5.3.1.2.2 Effectiveness and Implementation of the AMP

Overall, the RNP ASME Section XI, Subsections IWE program appears effective. All areas of the metallic liner where corrosion was observed have been refurbished and reinstalled to conform to the original design requirements. RNP also implemented a process, which removes and replaces the existing insulation panels with chloride-free insulation. The RNP program as implemented would meet the majority of GALL Rev. 2 recommendations because it addresses the moisture barrier and follows the guidance in the ASME

code for inspections of the other portions of the liner. The current program may not meet all of the recommendations in the GALL Rev. 2 program regarding inspection of high-strength bolts because the RNP program was developed based on GALL Rev. 0.

5.3.1.3 Recommendations for Subsequent License Renewal

5.3.1.3.1 Good Practices or Strengths of the AMP

The 2012 inspection revealed that the liner coating is less effective at locations where severe corrosion was found. Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the coating degradation and subsequent corrosion of the liner. An engineering analysis is performed by RNP to evaluate the possibility of the containment liner without the insulation and sheathing panels to enhance the accessibility of the liner and its long-term performance if it is proven that the liner is capable of performing its intended function without the insulation and sheathing panels. RNP conducted engineering

S1.S-1: *Recommendation*: Remove and replace the insulation with chloride-free insulation to prevent corrosion.
***Technical Basis*:** RNP removes and replaces the existing insulation containing chloride with the chloride-free insulations. This is considered a good practice and may be included in the preventive actions program element of this AMP.

5.3.1.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S1.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The ASME Section XI, Subsections IWE continues to be critical to the management of significant aging mechanisms such as corrosion in the steel containment because inaccessibility of the containment liner. The liner is covered by insulation and sheathing panels with caulked joints. Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels caused corrosion of the liner. Chloride contained in the piping insulation also caused corrosion at containment penetrations.

1. Scope of Program:

The RNP program includes Class MC pressure-retaining components and their integral attachments; metallic shell and penetration liners of Class CC pressure retaining components and their integral attachments; containment pressure-retaining bolting; and metal containment surface areas, including welds and base metal. The program and the 10 CFR 50 Appendix J Program manages aging effects on the containment pressure boundary components.

2. Preventive Action:

The 2012 inspection on inaccessible portion of the RNP containment liner revealed that the liner coating is less effective at locations where severe corrosion was found. Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the coating degradation and subsequent corrosion of the liner. RNP implemented a liner restoration process, which removes and replaces the existing insulation panels with chloride-free insulation during each outage to prevent liner corrosion.

The RNP program also identified corrosion of containment penetrations due to chlorides contained in the insulation of the piping. The penetrations were repaired as necessary and the insulation was replaced with chloride-free insulations to prevent corrosion.

S1.2-1: *Recommendation*: Add a discussion of removing or replacing the existing insulations at containment liner and piping penetrations with chloride-free insulations as a preventive action to prevent corrosion of liner and penetrations.
***Technical Basis*:** The 2012 RNP inspection revealed the presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels were the two major factors contributed to the coating degradation and subsequent corrosion of the liner. The chlorides contained in the insulation of the penetration piping also caused corrosion of containment penetrations.

3. <u>Parameters Monitored/Inspected</u>:

The parameters monitored/ inspected of concern in the program include:

- Loss of Material due to General Corrosion
- Loss of Material due to Galvanic Corrosion
- Loss of Material due to Aggressive Chemical Attack
- Loss of Material due to Crevice Corrosion
- Loss of Material due to Pitting Corrosion
- Change in Material Properties due to Elevated Temperature
- Cracking due to Elevated Temperature
- Cracking due to Thermal Fatigue

The AMP identified galvanic corrosion between dissimilar metals as an aging mechanism for containment penetration bellows. RNP design does not have any penetrations that are stainless steel. The existing dissimilar metal welds are located at the carbon steel penetrations and stainless s steel piping. The welds between the carbon steel liner and the carbon steel penetration is contained in the IWE Program and are examined under the IWE Program. The penetrations as well as most of the piping from these penetrations are insulated. Examinations are performed with insulation in place and on the surface if the insulation is removed for other work at the time of the examination.

S1.3-1: *Recommendation*: Include galvanic corrosion between dissimilar metals as an aging mechanism for containment penetration components in GALL. GALL does not list galvanic corrosion as an aging mechanism for containment penetration components.
***Technical Basis*:** Galvanic corrosion could occur at containment penetration between dissimilar metals. RNP does not have any penetrations that are stainless steel and dissimilar metal welds exist between the carbon steel penetrations and stainless steel piping. The parameters monitored/ inspected in the RNP program include loss of material due to galvanic corrosion.

4. <u>Detection of Aging Effects</u>:

The RNP containment liner is inaccessible. The liner is covered by insulation and sheathing panels with caulked joints. RNP committed to remove the sheathing and insulation from the bottom row 360° around the containment to examine the liner surface and the moisture barrier between the concrete and the liner over the duration of the second 10-year examinations. In addition, anytime a sheathing/insulation panel is removed from the containment liner, all the required ASME IWE examinations are performed.

The inaccessible portion of the containment liner and moisture barrier at the liner/containment floor interface was inspected by the RNP One-Time Inspection Program in 2005 with the insulation removed. The results indicated that the liner is acceptable until 2023 at the worst corrosion rate. Since 2005, RNP has continued to remove the lower row of panels during each IWE inspection period to replace the moisture barrier completely. RNP also implemented a separate liner restoration process, which removes and replaces the existing insulation panels with chloride-free insulation during each outage.

In 2012, 136 insulation and sheathing panels (about ~6% of the total panels) were removed to inspect the liner. Corrosion and bulge were observed at some areas. Engineering analysis indicated that there is no adverse effect on the ability of the liner plate to perform its intended function as a leak tight membrane. After the inspection, all areas of the metallic liner where corrosion was observed have been refurbished and reinstalled to conform to the original design requirements. The severity of the liner corrosion recorded during the 2012 inspection was similar to the previously evaluated corrosion dating back to 1993. The RNP engineering analysis ”Evaluation of Containment Building Liner, Insulation, Sheathing, and Coatings” determined that the metallic liner corrosion is at a relatively steady state based on the historical data.

The 2012 inspection revealed that the liner coating is less effective at locations where severe corrosion was found. Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the coating degradation and subsequent corrosion of the liner. An engineering analysis is currently being performed by RNP to evaluate the possibility of the containment liner without the insulation and sheathing panels to enhance the accessibility of the liner and its long-term performance if it is proven that the liner is capable of performing its intended function without the insulation and sheathing panels.

S1.4-1: *Recommendation*: Provide guidance in GALL about inspecting elements in contact with chloride insulation based on some sampling method.

***Technical Basis*:** Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the liner coating degradation and subsequent corrosion of the liner. Corrosion of containment penetrations also occurred in RNP due to leaching of chloride in the piping insulation.

S1.4-2: *Recommendation*: Future guidance should contain a clear definition of what portions of the containment liner are inaccessible and what inspection or analysis is expected for those areas.
***Technical Basis*:** It is unclear what is meant by 'inaccessible' in the ASME Code. Licensees have classified areas of the liner covered by abandoned leak chase channels or removable insulation as inaccessible as well as areas that are difficult to access (minimum clearance, underwater, ALARA concerns, etc.).

5. <u>Monitoring and Trending</u>:

All accessible surfaces are monitored by virtue of the examination requirements on a scheduled basis. The components, items and areas subject to the requirements of Subsection IWE are uniquely identified for tracking the required examinations and/or test completion.

6. <u>Acceptance Criteria</u>:

For some examinations, numerical values are specified for the acceptance standards for RNP. For the containment steel liner base metal, a numerical value for liner plate base metal degradation is specified. For liner plate degradation that has reduced thickness by greater than 10% or below the minimum design thickness specified by an engineering evaluation, requires an approved plant process to be accepted by an engineering evaluation or a corrective action.

In the audit, the staff noted that the ASME Section XI, Subsection IWE currently allows for owner defined acceptance criteria for degradation below 10 percent of the nominal wall thickness. This has led to confusion about how these criteria should be applied (general area or local degradation) as well as what is acceptable for degradation below 10 percent. There is also no clear discussion about when degraded areas should be coated and how this action affects future inspections or acceptance.

S1.6-1: *Recommendation*: It is recommended to develop clear guidance in GALL on the acceptance criteria for degradation below 10 percent of the nominal wall thickness and when areas should or should not be recoated.
***Technical Basis*:** ASME Section XI, Subsection IWE currently allows for owner defined acceptance criteria for degradation below 10 percent of the nominal wall thickness. This has led to confusion about how these criteria should be applied (general area or local degradation) as well as what is acceptable for degradation below 10 percent. There is also no clear discussion about when degraded areas should be coated and how this action affects future inspections or acceptance.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

The following OpE indicates that RNP AMP B.3.13 appears to be functioning effectively in that it is identifying and addressing aging-related problems.

(1) Based on the discovery of degraded protective insulation sheathing on the containment liner, administrative controls were upgraded to require a visual inspection of accessible interior and exterior surfaces of containment structures and components for evidence of deterioration. The NRC IR 2010008 of the RNP liner states that the inspectors reviewed a sample of engineering evaluations for the metal containment liner thickness and ensured that any areas of less than the minimum required thickness were properly dispositioned and repaired, if necessary.

(2) Corrosion was identified on the inside vertical face of the equipment hatch cylinder. The insulation was removed at the low point of the equipment hatch, the equipment hatch inspected and recoated as necessary.

(3) Localized bulging occurred on the RNP containment liner. The bulge was analyzed in the "RNP Unit No. 2 Containment Liner Stress Analysis Report," dated June 21, 1974. The bulge is believed to have been present since initial construction. A strain-monitoring program was initiated for one cycle which indicated no gross movement or growth of the liner. Two additional bulged liner areas were discovered in 1992. These areas are also believed to have existed since initial construction. These bulges were monitored in 1993 with negligible movement and were considered stable and acceptable, with no further monitoring required.

(4) Recent inspections identified that boric acid leakage has penetrated the epoxy construction joint seal near the ECCS sump. The watertight seal material at the ECCS Sump has cracked or separated from the adjacent concrete and permitted the borated water to migrate around the first level floor. There is the potential borated water could cause corrosion to the carbon steel rebar.

S1.10-1: *Recommendation*: Recommendations should be included in the containment liner program regarding actions to be taken if there is any indication that borated water leakage may have contacted the containment liner.
***Technical Basis*:** Although not identified at RNP, leakage of the refueling cavity has been a chronic industry issue. Guidance should be provided for how an applicant addresses this OpE (successful repairs, core bores, liner inspections of normally inaccessible areas, etc.).

The RNP containment liner is unique in that all vertical portions are covered by insulation. The licensee considers these portions of the liner to be inaccessible and has used the relief request process to keep from removing the insulation to inspect the liner during each period. The licensee is only required to perform an ASME Code Section XI, Subsection IWE inspection of the moisture barrier or the liner when a maintenance activity requires removal of insulation. During the first ten-year ASME Code Section XI, Subsection IWE inspection interval, which ended in 2008, the licensee removed the entire bottom row of insulation and inspected the liner and the moisture barrier. Based on the results of the inspection, the licensee identified a worst case corrosion rate and location. They determined that at the current rates, the liner is acceptable until 2023. Since that time, the licensee has continued to remove the lower row of panels during each ASME Code Section XI, Subsection IWE inspection period and has replaced the moisture barrier completely during each inspection period. The licensee further informed the NRC staff that RNP has committed to remove the entire bottom row of insulation again over the course of the second ten-year interval. The licensee also implemented a separate liner restoration process which removes and replaces insulation panels with chloride free insulation during each refueling outage.

5.3.2 ASME Section XI, Subsection IWL (XI.S2)

5.3.2.1 Objective and Scope of the AMP

The RNP program B.3.14 consists of periodic visual inspection of concrete surfaces of the RNP containment structures for signs of degradation, assessment of damage and corrective actions. The RNP has a prestressed containment. The prestressing tendons are grouted in place. Therefore, ASME Section XI Subsection IWL rules regarding un-bonded post-tensioning systems are not applicable. To provide assurance of the remaining prestressing capacity, RNP will perform structural integrity test (NUREG-1785, LR Commitment 45) to identify any horizontal cracks in the containment structures observed during the test as an indication of reductions in the prestress.

The ground water and lake water at RNP are considered aggressive (low pH value). To address aging management of inaccessible areas in containment, such as basemat, exposed to aggressive ground water, the AMP includes the tasks: (1) to use inspections of submerged portions of concrete throughout the site as a leading indicator for potential below-grade containment concrete degradation, (2) to monitor groundwater and lake water for aggressiveness and respond accordingly if a negative trend was identified, and (3) to inspect below-grade concrete when exposed for any reason.

5.3.2.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.2.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The RNP ASME Section XI, Subsection IWL Program manages the concrete portions of the containment building for change in material properties, loss of material, and cracking. The program manages aging with visual inspections conducted in accordance with the Part 50 required ASME Section XI, Subsection IWL Program. The staff determined during the audit that the overall program as implemented meets the requirements of GALL Rev. 2 AMP XI.S2

5.3.2.3.2 Areas of the AMP for Further Consideration/Enhancement

Since implementation, the IWL visual examinations have not identified any significant structural degradation. Minor concrete spalling and leaching has been identified and evaluated with no structural impact identified. The corrective actions have been appropriate and the number of findings appears to be appropriate and does not indicate a negative tend. Overall, the RNP ASME Section XI, Subsections IWL program appears effective in managing aging effect of concrete. However, it is not clear the program is effectively managing the aging effects associated with the prestressed reinforcement. As mentioned above, the prestressing tendons of the RNP containment are grouted in place. The grout provides an alkaline medium for protecting the tendons. The system cannot be monitored either for the remaining prestress level or for the effectiveness of the grout in protecting the tendons. They cannot be tested for prestress losses or visually inspected. To provide assurance of the remaining prestressing capacity, RNP is committed to perform structural integrity test (LR Commitment 45) to identify any horizontal cracks in the containment structures observed during the test as an indication of reductions in the prestress. However, the test will only be performed once in the period of the extended operation and will not be completed until 2017. The latest guidance of RG 1.90, “Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons”, Rev. 2, November 2012 recommends conducting pressure testing every five years for containment structures with grouted tendons. The frequency of the RNP structural integrity test does not meet the current guidance in RG1.90.

The requirements in the RNP Plant Procedure appear effectively in addressing below-grade containment structures exposed to aggressive ground water.

5.3.2.3 Recommendations for Subsequent License Renewal

5.3.2.3.1 Good Practices or Strengths of the AMP

The ground water and the lake water at RNP site is aggressive (low pH value). The AMP includes a task that uses inspection results of submerged portions of concrete structures throughout the site such as the intake structure, as a leading indicator. Engineering evaluation will be performed to evaluate the potential degradation for the below-grade containment concrete exposed to aggressive ground water based on the leading indicator. Establishing a leading indicator based on inspection results of the submerged structures through the site for potential degradation of other below-grade structures in the site is considered as a good practice.

S2.S-1: *Recommendation*: Using the inspection results of submerged portions of concrete structures throughout the site as a leading indicator to evaluate the potential degradation for the below-grade containment concrete exposed to aggressive ground water.
***Technical Basis*:** Degradation of the submerged concrete structures due to aggressive chemical attack would also occur to the below-grade containment structures.

5.3.2.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S2.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The ASME Section XI, Subsections IWL continues to be critical to the management of significant aging mechanisms for below-grade containment concrete for site with aggressive ground water such as the RNP site.

1. Scope of Program:

The RNP IWL Program manages the concrete portions of the containment building for change in material properties, loss of material, and cracking. As a program enhancement, examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of the program. To provide assurance of the remaining prestressing capacity in the grouted prestressing tendons, the program included performing structural integrity test (LR Commitment 45) to identify any degradation in the prestressed containment structures.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

The parameters Monitored/Inspected that are of concern in the program include:
- Change in Material Properties due to Aggressive Chemical Attack
- Loss of Material due to Aggressive Chemical Attack
- Loss of Material due to Corrosion of Embedded Steel
- Change in Material Properties due to Fatigue
- Cracking due to Fatigue

During refueling outage 27 in 2012, the licensee performed the ASME Section XI, Subsection IWL inspection for containment concrete degradation. The licensee's visual surface examination reports demonstrated that there was no major structural degradation. During the inspection the licensee identified localized chemical leaching that resulted in staining of the concrete surface. The licensee also observed minimal concrete spalling on the exterior of the containment cylindrical wall between the 180 degrees and 270 degrees azimuth. The licensee determined that the concrete staining and spalling observed will not affect the structural integrity and safety functions of the containment building.

4. <u>Detection of Aging Effects</u>:

Based on long-term monitoring from 1975 to 1995, the environmental parameters for lake water at the RNP intake structure are: average chloride concentration 3.14 ppm, average sulfate concentration 3.67 ppm, and average pH 5.46.

Based on semi-annual ground water monitoring required by the State of South Carolina, the environmental parameters of well #4 at the RNP site are: sulfate concentration 21.0 ppm, ground water pH 4.41 (chloride concentration no data available).

RNP groundwater values for chlorides and sulfates are much less than the threshold values necessary for aggressive chemical attack. However, the aging mechanisms associated with aggressive chemical attack and corrosion of embedded steel, are potentially applicable to below-grade concrete structures due to acidic groundwater. Groundwater pH has a measured range of 3.7 to 6.0 (average of 4.4). RNP enhanced the inspection requirements to apply a special inspection provision for monitoring aging effects potentially caused by aggressive chemical attack and corrosion of embedded steel. This involves inspecting the condition of below grade concrete that is exposed during excavation.

The AMP base document (RNP-L/LR0617) stated that periodic monitoring (semi-annual) of below-grade water chemistry (including consideration of potential seasonal variations) are performed to demonstrate that the below-grade environment is not aggressive.

The RNP is one of the few operating plants in which the containment prestressing tendons are protected from corrosion by means of cement grout. Though the cement grout provides a reliable alkaline medium for protecting the tendons, the tendon system cannot be monitored either for the remaining prestress level, or for the effectiveness of the cement grout in protecting the tendons.

Since the Structural Integrity Test (Commitment 45) used to identify any degradation in the prestress system will only be done once in PEO and will not be completed until 2017. This frequency of testing does not meet the current guidance in RG 1.90 Rev. 2, which recommends conducting pressure testing every five years. During the audit, RNP engineer stated that they would look into RG. 1.90 for the frequency interval of conducting containment pressure testing.

S2.4-1: *Recommendation*: GALL states that In general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. It is recommended to increase the frequency of ground water sampling in GALL from “not to exceed 5 years” to “semi-annual” or “quarterly”.
***Technical Basis*:** RNP performs periodic monitoring of below-grade water chemistry on semi-annual basis for capturing potential seasonal variations to demonstrate that the below-grade environment is not aggressive.

S2.4-2: *Recommendation*: It is recommended including guidance on aging management of containment with grouted tendon system in the GALL IWL AMP. This could be accomplished by incorporating the guidance in Regulatory Guide 1.90, “Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons,” Rev. 2 into the GALL Report. RG 1.90 recommends installing stress monitoring instrumentation during construction or conducting periodic pressure testing.

***Technical Basis*:** RNP has a prestressed containment with grouted tendons and the ASME Section XI Subsection IWL rules for unbonded post-tensioning systems are not applicable. The GALL report IWL program needs guidance on aging management of containment structures with grouted tendons.

5. Monitoring and Trending:

The current schedule for the IWL examinations is to complete the second 5-year examinations between November 9, 2001 and November 8, 2006. Subsequent examinations are performed at 5-year intervals following the expedited examination. The frequency and scope of examination of accessible areas are sufficient to ensure that the aging effects are detected before the design basis requirements would be compromised. Periodic monitoring (semi-annual) groundwater and lake water for aggressiveness and respond accordingly if a negative trend was identified.

6. Acceptance Criteria:

The concrete surfaces acceptance criteria are based on IWL-3000. It is consistent with GALL. The IWL responsible engineer is required to be a registered professional engineer to be qualified in accordance with RNP Engineering Support Personnel Job Specific Training Guides.

7. Corrective Actions:

RNP plant procedure specifies:
If the inservice examination results do not meet the acceptance standards established by the responsible engineer, the component shall not be returned to service until an engineering evaluation is performed with the information listed below:

- the cause of the condition which does not meet the acceptance standards;
- if a repair is not required, the acceptability of the concrete containment without repair of the component;
- if a repair is required, the extent, method, and completion date of the repair must be specified;
- determination if a leakage test is required;
- extent, nature, and frequency of additional examinations (if required).

8. Confirmation Process:

The plant Containment Inspection Program procedure provides actions for resolving unacceptable inservice results based on IWL-3300. These actions consist of preparing an engineering evaluation which includes the extent, nature, and frequency of additional examinations, if required.

9. Administrative Controls:

No further review item identified.

10. <u>Operating Experience</u>:

The plant procedure Inservice IWE/IWL Program currently comprises the “First Containment Inspection Interval” effective from September 9, 1998 to September 8, 2008. This time frame includes the first and second five year examinations required by Subsection IWL. Previous inspections were conducted in accordance with 10 CFR 50 Appendix J and the Maintenance Rule Inspection Program. Maintenance Rule baseline inspections of the containment were completed in the fall of 1996. The inspections performed under these programs were previously documented and evaluated for any degraded conditions associated with the containment leak tight barrier.

The RNP OpE includes:

- Degraded conditions in the containment structure concrete components for the North and South Cable Vault Rooms were observed. Staining, cracking, exposed aggregate, and spalling were identified. The indications were characterized as minor, and no signs of corrosion in the cracks were noted.

- An evaluation concluded that not providing cooling to the penetrations with hot piping does not degrade the concrete. Degradation has not occurred and does not require augmented examinations.

- During refueling operations at RNP, the reactor cavity is flooded with borated water from the refueling water storage tank to enable submerged fuel movement. The structure has reinforced concrete walls with a stainless steel liner. In 2012, RNP performed an evaluation of potential concrete degradation by borated water leakage from reactor cavity seal. The analysis concluded that the reinforced concrete inside containment that may have been in contact with this leakage would not have experienced significant degradation.

- The overall health (between7/1/2012- 9/30/2012) of the IWE/IWL Containment Inspection Program/Plan at RNP is White with a score of 87.50. The trend in the program health is rated stable.

- Inspection of the exterior surface of the containment dome concrete revealed accelerated degradation of the grout covering in December of 1984. A work package was issued to repair this degradation and specified that an elastomeric coating system be applied after the grout was stripped and resurfaced. The evaluation indicated that grout deterioration did not affect the structural integrity of the associated concrete.

- Inspections of surveillance block tendons:

  The surveillance tendons consist of six 1-3/8 inch diameter bars grouted in a six inch pipe sheath with anchor plates and prestressing-hardware, which is identical to the service tendon except for the length. They are embedded in a section of concrete

approximating the same environment as that of the service tendons. The surveillance blocks were placed next to the containment to subject them to a similar unsheltered outdoor environment. The surveillance block tendons were inspected at a 5-yr and 25-yr intervals. The conclusions for both the 5- and 25-year surveillance blocks indicate there is no significant corrosion, and mechanical testing of the tendon bars also show no significant change in properties. While no specific inspection criteria were provided for the grout, it was noted that the grout cracked as the pipe was cut and stress relieved from the bars. Also in some areas, separated grout had a reddish-brown stain at the contact surface with the bars that was suspected to be an oxide that formed during construction.

During the audit session, RNP engineer stated that that here are no surveillance tendons remaining for inspection during the period of extended operation. To address the lack of monitoring and to provide assurance of the remaining capacity, RNP committed in the license renewal application (Commitment 45) that a Structural Integrity Test of the tendon system will be performed during the period of extended operation. The test will be coupled with IWL visual inspections with emphasis on identifying horizontal cracks indicative of reductions in the prestress.

- The below-grade or submerged concrete structures exposed to ground water or lake water were inspected to assess the effects of the aggressive ground/lake water. The inspection results are:

(a) Below-grade of the RAB (Reactor Auxiliary Building):

A visual inspection of the below-grade portion of the RAB foundation approximately three feet deep was performed in July 1999. No signs of spalling or other concrete degradation were observed.

(b) The interiors of eight manholes were visually examined in August 2002. The interior concrete has been partially submerged from ground water and provides a similar environment as below-grade concrete (exposure to acidic ground water). No cracking, loss of material, or change in material properties was observed in the concrete surface.

This OpE indicates that the RNP IWL AMP appears to be effective in identifying and addressing aging-related problems.

S2.10-1: *Recommendation*: GALL may recommend visual inspection of interior surface of manhole for detecting concrete degradation.
***Technical Basis*:** The manhole is embedded in ground. The manhole concrete is exposed to similar environment as the below-grade containment concrete. Degradation of concrete in the manhole could indicate degradation in the below-grade containment concrete.

5.3.3 ASME Section XI, Subsection IWF (XI.S3)

5.3.3.1 Objective and Scope of the AMP

The RNP ASME Section XI, Subsection IWF Program manages ASME Class 1, 2, and 3 component supports for loss of material due to corrosion and loss of mechanical function. The program manages aging with VT-3 visual inspections conducted in accordance with ASME Section XI, Subsection IWF requirements. There were no enhancements or exceptions of this program.

5.3.3.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.3.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The RNP ASME Section XI, Subsection IWF Program manages ASME Class 1, 2, and 3 component supports for loss of material due to corrosion and loss of mechanical function. The staff determined during the audit that the overall program as implemented meets the requirements of GALL Rev. 2 AMP XI.S3.

5.3.3.2.2 Effectiveness and Implementation of the AMP

No significant changes were identified in procedures since the license was issued. Since implementation the IWF visual examinations have not identified any significant degradation. Minor degradation (general corrosion, loose bolts, etc.) has been identified and repaired as necessary.

Based on plant OpE it appears the program is effective. The review of OpE and testing results has led to the proper corrective actions. The number of findings appears to be appropriate and does not indicate a negative trend. The RNP program as implemented would meet the recommendations of GALL Rev. 2.

5.3.3.3 Recommendations for Subsequent License Renewal

5.3.3.3.1 Good Practices or Strengths of the AMP

Self-assessments and Health Report have been performed periodically to assess the effectiveness of the Inservice Inspection programs. CRs were initiated as a response to the findings of the self-assessment and corrective actions performed. This is considered as good practice and strength of the AMP.

5.3.3.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S3.0-1: *Recommendation*: This AMP is rated a High priority for future AMP audits.
***Technical Basis*:** The ASME Section XI, Subsections IWL continues to be critical to the management of significant aging mechanisms for below-grade containment concrete for sites with aggressive ground water, such as the RNP site.

1. Scope of Program:

The RNP IWL Program manages the concrete portions of the containment building for change in material properties, loss of material, and cracking. As a program enhancement, examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of the program. To provide assurance of the remaining prestressing capacity in the grouted prestressing tendons, the program included performing structural integrity test (NUREG-1785, LR Commitment #45) to identify any degradation in the prestressed containment structures.

2. Preventive Action:

No preventive actions are specified; The RNP Subsection IWF AMP is a monitoring program

3. Parameters Monitored/Inspected:

The parameters monitored/ inspected of concern in the program include:

- Loss of Material due to General Corrosion
- Loss of Material due to Aggressive Chemical Attack (only applicable for the reactor vessel nozzle supports)

4. Detection of Aging Effects:

During the audit, the licensee explained that when a degraded support is identified it is returned to an ‘as new’ state regardless of whether or not the support was still acceptable per the ASME Section XI, Subsection IWF acceptance criteria. If the support does not fail the ASME acceptance criteria, none of the associated actions are taken (sample expansion, additional inspections) and the support remains in the IWF sample. The NRC staff discussed with the licensee that this could lead to a situation where age-related degradation of a support within the IWF inspection sample is identified and repaired while supports outside the sample continue to degrade; eventually it may progress to a point where the IWF sample is not representative of the total support population. The licensee indicated that this was not an issue, because, if supports outside of the ASME IWF sample are degrading, they will be identified during system walk-downs and repaired as necessary. This issue has been identified at multiple sites and may be an area requiring additional discussion in future guidance.

In addition to the above suggestion based on OpE, future guidance should revisit the adequacy of the IWF sample size and inspection frequency. The original guidance for sample selection and inspection requirements was based on an assumed plant life of 40 years. For subsequent renewal it may be necessary to increase the sample size or the frequency of inspections to detect aging degradation in an effective manner. This is an issue that should be monitored as more plants enter the period of extended operation.

S3.4-1: *Recommendation*: Revisit the adequacy of the IWF sample size and inspection frequency in GALL.
***Technical Basis*:** The original guidance for sample selection and inspection requirements was based on an assumed plant life of 40 years. For subsequent renewal it may be necessary to increase the sample size or the frequency of inspections to detect aging degradation in an effective manner.

5. Monitoring and Trending:

Inspections are performed at such a frequency that structural degradation and general corrosion is detected before the component support's structural integrity is compromised. Visual inspection (VT-3) results that do not satisfy the acceptance standards of the code are evaluated by Civil Engineering to determine required action. Civil Engineering evaluates the recordable indication and determines the operational status of the identified component for functionality

6. Acceptance Criteria:

The program utilizes the ASME Code's acceptance standards (Section IWF- 3400) to disposition observed flaw indications. Corrosion must be early stages, superficial, surface rust and of no structural consequence.

7. Corrective Actions:

Component supports determined to be nonfunctional will have corrective actions performed to restore them to the original design condition or to an approved alternate design. This is generally corrected by a maintenance work order or an Engineering Change document.

8. Confirmation Process:

Program effectiveness is monitored using site QA procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B.

9. Administrative Controls:

No further review item identified.

10. <u>Operating Experience</u>:

The RNP OpE from the past five refueling outages includes:

RO 21 - Identified boric acid leakage from the reactor cavity onto the reactor support structure during refueling operations. Recommended a visual inspection of the reactor supports in next outage.

RO 20 - 7 supports were inspected with no operability or loss of function identified. Work Requests were initiated to correct items such as loose nuts.

RO 19 - 31 supports were reviewed by Engineering with no operability or loss of function identified. Work Requests were initiated to correct items such as tighten loose nuts, remove paint, reset spring cans, replace pipe clamp bolts, add/remove bolts, install shims. In some instances, drawings were revised (ESR 98-00416) to reflect as-built conditions.

RO 18 - 28 supports were inspected. Eleven (11) supports had recordable degradation in accordance with ASME Section XI, Subsection IWF. Items were primarily missing or loose locknuts. Two spring cans required minor resetting. Some had minor rust or design documentation problems. Some had pipe clearance, baseplate gaps or thread engagement problems slightly different from the as-built sketches. All supports were either acceptable or functional with the exception of one support on the charging line (CVCS 3-CH-15A Support “T”), which was not functional. This was due to loose nuts on baseplate bolts and a gap between the baseplate and wall.

The scope was expanded to include 5 additional supports. Support “P” also was non-functional due to loose washers and not being able to rotate the nuts. An additional 28 supports were examined with no additional unacceptable conditions. Support “P” was later determined to have been functional by Engineering. CR 98-00694 was identified. The cause of the condition was determined to be the failure to consider thermal expansion during original design. This is not considered to be an aging mechanism.

RO 17 – 54 supports were inspected. Thread engagement deficiencies were noted. Action Requests were initiated and converted to work request for correcting the deficiencies.

The OpE indicates that the RNP IWE AMP appears to be effective in identifying and addressing aging-related problems of supports. The scope of sampling is expanded if degradation is detected. Actions Requests were initiated for correcting the deficiencies.

5.3.4 10 CFR 50, Appendix J (XI.S4)

5.3.4.1 Objective and Scope of the AMP

The RNP 10 CFR Part 50, Appendix J AMP B.2.7 manages the reactor containment building and associated pressure-retaining components for cracking, change in material properties, loss of material and loss of leak-tightness. It manages aging with visual inspections and periodic pressure testing of the entire containment (Integrated Leak Rate Testing, ILRT) and individual penetrations (Local Leak Rate Testing, LLRT). There was an associated commitment (Commitment 45) to perform a Structural Integrity Test (SIT) during the period of extended operation. This commitment was to provide assurance of design capacity of the containment-grouted tendon during the period of extended operation.

5.3.4.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.4.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

> The program description was found to be satisfactory. This program consists of inspections of accessible surfaces of containment and monitoring of leakage rates through containment liner/welds, penetrations, fittings, and access openings for detecting degradation of the containment pressure boundary. Corrective actions are taken if leakage rates exceed acceptance criteria. This program is implemented in accordance with 10 CFR Part 50, Appendix J, RG 1.163, and NEI 94-01, Rev. 0.

5.3.4.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are:

> Based on plant OpE it appears the program is effective. The review of OpE and testing results has led to the proper corrective actions. Overall Type B and C leakage results have remained steady with no indication of a negative trend. The program also identified OpE with corrosion of penetrations due to insulation containing chlorides. The penetrations were repaired as necessary and the insulation was replaced with chloride-free insulation. The RNP Appendix J program as implemented would meet the recommendation of GALL Rev. 2.

5.3.4.3 Recommendations for Subsequent License Renewal

5.3.4.3.1 Good Practices or Strengths of the AMP

As mentioned above, the program identified OpE with corrosion of penetrations due to insulation containing chlorides. The insulation was replaced with chloride-free insulation. Replacing of penetration insulation with chloride-free insulation is considered as a good practice.

S4.S-1: *Recommendation*: The GALL AMP could recommend licensee replacing the insulation containing chlorides with chloride-free insulation at containment penetrations as a preventive measurement for corrosion.
Technical Basis: Corrosion has occurred at the RNP containment penetrations due to leaching of chlorides in the insulation.

5.3.4.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S4.0-1: Recommendation: This AMP is rated a Medium priority for future AMP audits. **Technical Basis:** During the audit the licensee indicated that the Appendix J AMP follows the requirements of Part 50 Appendix J and does not add any additional requirements. The program appears stable and effective.

1. Scope of Program:

This program consists of inspections of accessible surfaces of containment and monitoring of leakage rates through containment liner/welds, penetrations, fittings, and access openings for detecting degradation of the containment pressure boundary. There was an associated commitment (Commitment 45) to perform a SIT during the period of extended operation. This commitment was to provide assurance of design capacity of the containment grouted tendon during the period of extended operation.

2. Preventive Action:

The insulation at containment penetrations was replaced with chloride-free insulation for preventing corrosion.

3. Parameters Monitored/Inspected:

The Parameters Monitored/ Inspected of the aging effects/mechanisms of the RNP 10 CFR 50 Appendix J AMP include:

- Cracking due to Elevated Temperature

- Cracking due to Thermal Fatigue
- Change in Material Properties due to Elevated Temperature
- Loss of Material due to General Corrosion
- Loss of Material due to Wear
- Loss of Material due to Aggressive Chemical Attack
- Loss of Material due to Crevice, Galvanic, and Pitting Corrosion

S4.3-1: *Recommendation*: Considering adding aging effects/mechanisms in the GALL AMR table for penetration sleeves and penetration bellows. This includes loss of material due to galvanic corrosion and aggressive chemical attack.
Technical Basis: These aging effects/mechanisms could occur on containment pressure boundary components. Galvanic corrosion due to dissimilar metals has occurred at the RNP containment bellows.

4. <u>Detection of Aging Effects</u>:

The RNP leak rate testing program is described in the corporate procedure and plant program procedure, and implemented by technical management procedure, which directs the performance of Type A, B and C leak rate tests for the RNP containment and all its penetrations. An inspection of the accessible surfaces of the containment is performed during each refueling outage as directed in the plant "Containment Isolation Valve Local Leakage Rate Survey," which provides additional procedures that perform various lower tier leak-testing functions. Type B tests are conducted on a refueling outage interval, not to exceed a maximum interval of two years. This frequency of testing will continue to be used for the extended period of operation.

During the audit, the RNP engineer stated that leakage limits are not established for individual penetrations that have bellows. Limits are established for groups of mechanical penetrations. If any group of mechanical penetrations exceeds its limit, individual penetration(s) is isolated for evaluation and repair. This allows detection of degradation of individual bellows on the penetrations during Type B testing.

During the audit, the RNP engineer stated that the pressure of containment leak rate test was increased after EPU based on containment analysis. This is consistent with other plants such as NMP-1 in increasing test pressure in the containment leak rate test after EPU modification.

S4.4-1: *Recommendation*: It is recommended adding the following statement in GALL to reflect the need to take EPU modifications into consideration: "For plant with EPU modification, it may require higher test pressures in the Appendix J containment leak rate tests."
***Technical Basis*:** The RNP has undergone EPU. During the audit, the RNP engineer stated that the pressure of containment leak rate test was increased after EPU based on containment analysis. This is consistent with other plants such as NMP-1 in increasing test pressure in the containment leak rate test after EPU modification.

5. Monitoring and Trending:

Plant 10 CFR 50, Appendix J Testing Program procedure states that the Type B and C tests are performed at a refueling cycle frequency in accordance with the requirements of Option A of 10 CFR 50 Appendix J, and Type A tests are performed at a performance based frequency in accordance with the requirements of Option B of 10 CFR 50 Appendix J. The plant procedure references NEI 94-01 as the basis for Type A testing frequency, and also references RG 1.163. The plant technical specification further states that the Appendix J program is in accordance with the guidelines presented in Regulatory Guide 1.163. This is consistent with the GALL AMP program element.

6. Acceptance Criteria:

Acceptance criteria for leakage rates are defined in plant procedure.

7. Corrective Actions:

The RNP plant Containment Inspection Program procedure requires that the 10 CFR 50 Appendix J acceptance criteria be satisfied before returning the affected component to service after repair. The plant Appendix J Testing Program procedure contains specific instructions of individual leak test for repair or replacement and retesting for any isolation component that has excessive leakage. RNP plant Appendix J Testing Program procedure further requires an increase in Type A testing frequency following failure of any Type A test. Program effectiveness is monitored using site QA procedures, review and approval processes, and administrative controls which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

RNP Appendix J Testing Program procedure directs the confirmation of the acceptability of the Type B and C test results and appropriate documentation of failures or discrepancies. Such documentation results in repair/replacement of affected components and assessment of the condition under 10 CFR 50.72 and 10 CFR 50.73.

10. Operating Experience:

RNP performed IRLT in 1992 and 2007 and plans to perform IRLT in 2017. The RNP engineer stated that no issues were found in the recent IRLT test. Results of type B and type C data are fluctuated, overall there is no issue. Since implementation of the 10 CFR Part 50, Appendix J Program, the licensee's pressure testing program has identified minor expected degradation such as individual

penetrations exceeding the administrative leakage limits. The licensee indicated that these issues have been assessed and corrected as necessary (e.g., reworking the valves, re-lining the valves, etc.). The NRC staff determined that the corrective actions and the number of findings associated with the program to the date of the audit are appropriate and do not indicate a negative trend.

SCC on stainless steel penetration bellows occurred at RNP due to exposure to chlorides. This was corrected by changes to the penetration design and by replacing the penetration piping insulation with a chloride-free type. The OpE provides assurance the 10 CFR 50 Appendix J Program has been successful at detection of leakage at penetration bellows and implementing actions to replace bellows as necessary

During the audit the licensee indicated that the Appendix J AMP does not add much value. The licensee follows the requirements of Part 50 Appendix J, and the license renewal program does not add any additional requirements. In future revisions of license renewal guidance, the staff believes that it may be appropriate to focus on the recommendations for managing aging that are unique to the period of extended operation.

5.3.5 Structures Monitoring (XI.S6)

5.3.5.1 Objective and Scope of the AMP

RNP implements this program through its AMP B3.15, “Structures Monitoring Program.” The Structures Monitoring Program is credited for aging management of civil structures and components within the scope of license renewal at RNP. The program consists of periodic inspection and monitoring the condition of structures and non-ASME structure component supports. The inspection criteria are based on ACI 349.3R-96 and ASCE 11-90; as well as INPO Good Practice document 85-033, “Use of System Engineers,” NEI 96-03, “Guidelines for Monitoring the Condition of Structures at Nuclear Plants,” and NUMARC 93-01, “Industry Guidelines for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants.”

5.3.5.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.5.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The program consists of periodic inspection and monitoring the condition of structures and non-ASME structure component supports. Program activities identify degradation of materials of construction, which include structural steel, concrete, masonry block, sealing materials. The program was initially developed to meet the regulatory requirements of 10 CFR 50.65 Maintenance Rule and, implements guidance provided in Regulatory Guide 1.160, NUMARC 93-01, and NEI 96-03.

5.3.5.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

The Structures Monitoring Program is a combination of corporate procedure “Condition Monitoring of Structures” and plant technical management procedure “System Walkdown Procedure.” Condition Monitoring of Structures provides direction to the responsible engineer for monitoring the structural condition of systems included in the scope of 10 CFR 50.65, “Maintenance Rule”. The System

Walkdown Procedure provides instructions for conducting scheduled system walkdowns, generating system heath reports, and performance monitoring of structures.

The program is an existing program with eight (8) enhancements (Commitment 26):

- Expand the program to include the structures and components in the scope of license renewal but not within the scope of Maintenance Rule.

- Identify interfaces between structure monitoring and fire protection program.
- Enhance inspection criteria and inspection personnel responsibilities.
- Revise administrative controls to provide inspection criteria for portions of structures covered by structural monitoring and require corrective actions to be initiated for unacceptable inspections.
- Expand system walkdown inspection criteria to include observation of adjacent components.
- Inspect above-grade accessible concrete.
- Revise personnel responsibilities to include providing assistance for evaluating structural deficiencies when requested, inspect excavated concrete to monitor for potential aging effects, and notifying civil/structural design engineering of proposed excavations.
- Include trending of groundwater monitoring to ensure any potential degradation of concrete due to aggressive ground water chemistry is identified.

The Structures Monitoring Program is implemented with a 10-year frequency for maintenance rule structures such as the Reactor Auxiliary Building, Fuel Handling Building, etc. The current process allows more frequent inspections if necessary or deemed appropriate. The program includes guidance on inspection of vibration isolators looking for degradation of the elastomeric material. It is consistent with Rev. 2 of the GALL. For structural bolting, the program provides inspection attributes consistent with GALL Rev. 2 for ASTM A325 and ASTM A490 structural bolting. RNP currently trends groundwater annually and monitors pH, sulfates, and chlorides. It is consistent with Rev. 2 of the GALL.

Overall, the GALL Structures Monitoring Program is appropriately implemented at RNP.

5.3.5.3 Recommendations for Subsequent License Renewal

5.3.5.3.1 Good Practices or Strengths of the AMP

The enhancement in Commitment No. 26 that expands system walkdown inspection criteria to include observation of adjacent components is a good practice. The whole room-components, equipment, cable trays, etc., are observed, not just the condition of the concrete walls and structural steel. RNP accesses system health conditions and documents System Health Report periodically (at least once a year and twice a year for selected systems). It is considered as a good practice.

5.3.5.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S6.0-1: Recommendation: This AMP is continuously rated as a High priority for future AMP audits.
Technical Basis: This AMP is continuously rated as a High priority for future AMP audits because of potential degradation of below-grade structures due to aggressive ground and lake water.

1. Scope of Program:

The program consists of periodic inspection and monitoring the condition of structures and non-ASME structure component supports. Program activities identify degradation of materials of construction, which include structural steel, concrete, masonry block, sealing materials.

The program manages aging of the seismic joint filler commodity by visual inspection to note any indication of movement or distress, as well as a determination that the gaps between buildings meet design requirements and are free of debris.

S6.1-1: Recommendation: It is recommended that adding inspection and monitoring of seismic joint filler and gaps between structures in the GALL.
Technical Basis: Degradation of seismic joint filler and reduction of gap size increase potential of structural impact during seismic event.

2. Preventive Action:

The RNP program is an inspection and monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

3. Parameters Monitored/Inspected:

The Parameters Monitored/ Inspected of the aging effects/mechanisms of the RNP Structures Monitoring AMP include:

Steel aging effects/mechanisms:
- Loss of Material due to General Corrosion
- Loss of Material due to Crevice Corrosion
- Loss of Material due to Pitting Corrosion

Concrete (below-grade) aging effects/mechanisms:

- Loss of Material due to Aggressive Chemical Attack
- Loss of Material due to Corrosion of Embedded Steel
- Change in Material Properties due to Aggressive Chemical Attack

Elastomer aging effects/mechanisms:
- Change in Material Properties due to Elevated Temperature
- Cracking due to Elevated Temperature

Seismic joint filler
- Change in Material Properties due to Elevated Temperature
- Cracking due to Elevated Temperature

S6.2-1: Recommendation: It is recommended that adding Parameters Monitored/Inspection for seismic joint filler such as Change in Material Properties and cracking due to Elevated Temperature.
Technical Basis: Degradation of seismic joint filler and reduction of gap size increase potential of structural impact during seismic event.

4. <u>Detection of Aging Effects</u>:

The structures monitoring program implementing procedure includes personnel qualification and acceptance criteria and is based on ACI 349.3R-96 and is consistent with the GALL 2. The licensee's procedure recommends the inspectors review previous CRs and work orders before the walkdowns to identify any specific areas of concern.

The licensee believes the structural inspections performed for license renewal are more complete or 'holistic', than what was done in the past for Maintenance Rule. The whole room-components, equipment, cable trays, etc, are observed, not just the condition of the concrete walls and structural steel.

The Maintenance Rule structures, such as the Reactor Auxiliary Building, Fuel Handling Building, etc., are walked down with a frequency not to exceed ten years, in accordance with the maintenance rule guidelines. The 10-year inspection interval was accepted in the SER for license renewal. The current process allows for more frequent inspections if necessary or deemed appropriate.

On the firewall inspection, RNP engineer indicated that the fire walls are also inspected by fire protection team. The fire protection team conducts fire wall inspection more frequently than structures monitoring.

The ground water and lake water at RNP is aggressive (low pH value). Plant Procedure has the following requirements for addressing below-grade structures exposed to aggressive ground water.

- Degradation to submerged concrete observed during periodic underwater inspections at the Intake Structure and RNP Dam Spillway will be used as a leading indicator for potential degradation to other below grade concrete structures in the scope of RNP License Renewal.

- Degradation to below grade concrete exposed during excavation will be used as a leading indicator for potential degradation to remaining below grade concrete structures in the scope of RNP License Renewal.

- Groundwater and lake water monitoring results (pH, chlorides, sulfates) will be reviewed by Engineering and trended. Increasing aggressiveness of the groundwater and lake water will be used as a leading indicator for potential degradation to below grade concrete structures in the scope of RNP License Renewal.

- Engineering will evaluate if the leading indicators for potential degradation to concrete are or are not common to other structures in the scope of License Renewal and will initiate appropriate corrective actions.

S6.4-1: Recommendation: Consider use "Degradation of submerged concrete observed in underwater inspections" as a leading indicator in GALL for potential degradation to other below-grade concrete structures in the scope of License Renewal.
Technical Basis: Degradation of submerged concrete observed in underwater inspections by diver would indicate potential degradation for all below-grade concrete structures in the scope of License Renewal.

S6.4-2: Recommendation: Consider use "Increasing aggressiveness of the ground water/lake water" as a leading indicator in GALL for potential degradation to below-grade concrete structures.
Technical Basis: Increasing aggressiveness of the groundwater/lake water would indicate potential degradation for all below-grade concrete structures in the scope of License Renewal.

5. <u>Monitoring and Trending</u>:

System Health Reports are generated for all systems within the scope of the System Walkdown Procedure, no less than once a year and twice a year for selected systems. Reports are retained in the system notebooks for three years. The "System & Component Trending Program and System Notebooks" provides specific information on system notebooks. Such monitoring and trending is satisfactory basis for meeting the attribute.

RNP implements the trending and evaluation of lake water and ground water in the requirements of plant procedure, "Condition Monitoring of Structures."

6. <u>Acceptance Criteria</u>:

A set of acceptance criteria are provided for steel, concrete, and elastomers. Structures are determined to be “Acceptable,” “Acceptable with Deviations,” or Unacceptable.” The concrete surfaces inspection quantitative acceptance criteria described in ACI 349.3R-96 are implemented. Concrete surface condition attributes are generally acceptable without further evaluation if

- Voids less than 20mm (3/4-in.) in diameter or equivalent surface area
- Scaling less than 5mm (3/16-in.) in depth
- Spalling less than 10mm (3/8-in.) in depth and 100mm (4¼-in.) in any dimension
- Passive cracks less than 0.4mm (0.015-in.) in maximum width

Concrete surfaces protectively lined with either a metallic or plastic (non-polyvinyl chloride) liner system are acceptable under the following criteria:

(a) Without active leak detection system
- Absence of bulges or depressions in liner plate which are age related
- Absence of corrosion or other liner damage
- Absence of cracking or deterioration of base metal and weld metal
- Absence of detectable leakage in leak detection system which is in excess of amounts and flow rates in the original design or technical specifications.

(b) With active leak detection system
- Leakage exceeding amounts and flow rates committed to in the original design or Technical Specifications. Leakage within the prescribed limits may be acceptable if the source is known and not found to be consequential.

7. <u>Corrective Actions</u>:

Condition Report is initiated for any condition identified as “Unacceptable”. Condition Reports are controlled as part of the Corrective Action Program, which is in accordance with 10 CFR 50, Appendix B. Plant procedure is enhanced to require corrective action as appropriate in accordance with the Corrective Action Program for degradations or deficiencies which could compromise component or system design functions or which could prevent the ability to perform within design basis allowable load, stress, deflection, or functional limits.

8. <u>Confirmation Process</u>:

Program effectiveness is monitored using site QA procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR 50, Appendix B.

9. <u>Administrative Controls</u>:

Corporate and Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50.

10. <u>Operating Experience</u>:

The licensee monitors lake water and ground water for pH, chloride and sulfate. During the audit, the last 3 years of data was reviewed. Chlorides and Sulfates trending is to be well below GALL threshold levels; pH remains below the 5.5 threshold as well. The data remains stable in the last years.

The inspection report for the 2005 inspection of the RNP dam spillway by divers was reviewed. No issues were identified related to concrete aging. "Opportunistic" inspections of below grade concrete are rare. When they have occurred, no degradation was noted.

The licensee identified indications of a small leak in the area above the fuel transfer canal in the spent fuel pool. The licensee attempts to locate and seal the leak that have been unsuccessful. The licensee also indicated that leakage in the reactor cavity seal has been observed for several refueling outages.

The licensee also indicated that the refueling canal leakage is due to the reactor cavity seal installed around the reactor during refueling outages and has been an issue for several years. The licensee stated that a permanent cavity seal is planned to be installed during the fall 2013 refueling outage. Following the audit, the licensee informed the NRC staff that the permanent cavity seal had been installed.
RNP engineer indicated that the fire walls are also inspected by fire protection team. The fire protection team conducts fire wall inspection more frequently than structures monitoring. The auditor asked about any differences in acceptance criteria between Structural Monitoring AMP and Fire Protection AMP. The licensee was not aware of any differences in the acceptance criteria.

The RNP roof design is a flat roof with a waterproofing membrane. The licensee identified persistent roof leakage in some structures. The NRC staff notes that the roof leaks could cause electric problems if water drips on energized equipment. The licensee stated that the leaks are continuously monitored, but repairs have been slow due to scheduled considerations. The licensee also informed us following the audit that the Auxiliary building roof was replaced in late 2012 to early 2013. The audit team felt that GALL may need to provide some guidance on roof leaking.
S6.10-1: Recommendation: It is recommended that GALL provide some guidance on aging management of roof leaking and adding roof leaking in the program element 10, OpE. **Technical Basis**: Roof leaking could cause problems for electric equipment below the roof and repair is expensive.

5.3.6 RG 1.127 Inspection of Water-Control Structures Associated with Nuclear Power Plants (XI.S7)

5.3.6.1 Objective and Scope of the AMP

RNP implements this program through its AMP B3.16, “Dam Inspection Program.” The Federal Energy Regulatory Commission (FERC) and the U.S. Army Corp of Engineers (USACE) program: “Recommended Guidelines for Safety Inspection of Dams,” is credited by RNP for the aging management of the Lake Robinson earthen dam and associated concrete structures. Lake Robinson reservoir provides plant cooling water and fire protection water. The FERC/USACE program is an acceptable method documented in GALL for managing aging effects of Lake Robinson dam. The program provides for periodic visual inspections of the earthen and concrete structures within the scope of LR. Program activities identify degradation of materials of construction, which include structural steel, concrete, earthen embankments, and outlet works.

5.3.6.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.6.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

The program description was found to be satisfactory. The program is a plant-specific AMP for managing aging effects of Lake Robinson dam and associated water-control structures in accordance with the FERC/USACE program, “Recommended Guidelines for Safety Inspection of Dams.” The program requires that the Lake Robinson Dam Embankment, accessible spillway concrete and steel commodities shall be inspected at a 5-year inspection interval. This includes a full travel test of each Tainter gate with the stop logs installed. The Lake Robinson Dam submerged spillway concrete shall be inspected at an inspection interval not to exceed 10 years. Results of these inspections shall be reviewed by the responsible engineer for the Lake Robinson Dam and corrective actions initiated for any unacceptable attributes. The Lake Robinson Dam shall be monitored for loss of form due to settlement.

5.3.6.2.2 Effectiveness and Implementation of the AMP

The NRC staff reviewed the most recent Dam Safety Inspection Reports. The overall conclusion from the 2010 report was that “The H.B. Robinson Cooling Lake Dam is adequately designed and adequately constructed. It is in good condition with no visible dips, sags, slumps, sinks or other evidence of distress. The upstream rip rap is sound, and the downstream grass cover is well

established. Maintenance of the dam by plant personnel is acceptable, and the dam is routinely inspected by plant personnel." The 2012 inspection report had similar conclusions.

The AMP has a Commitment (No. 27) that includes:

- Identify the "Recommended Guidelines for Safety Inspection of Dams" as the required document for the dam AMP
- Require the responsible system engineer to review the inspection reports and initiate corrective actions for any unacceptable attributes.
- Include "Recommended Guidelines for Safety Inspections of Dams" as the applicable inspection guidance in the inspection procedure.
- Inspect above-grade accessible concrete
- Inspect submerged spillway concrete on a frequency not to exceed 10 years.
- Include trending requirement for structures based on aggressive groundwater and lake water.

The Commitment 27 has been implemented in the plant procedures.

- Revise the System Walkdown Procedure to identify the FERC/USACE program, "Recommended Guidelines for Safety Inspection of Dams" as the required management program document and require the responsible system engineer to review the inspection report and initiate corrective actions for any unacceptable attributes identified during the inspection process.
- Revise plant procedure "Dams, Embankments, and Canals" to include "Recommended Guidelines for Safety Inspections of Dams" as the inspection guidance for RNP.
- Revise the Systems Walkdown Procedure to include an inspection of submerged spillway concrete at an interval not to exceed (10) ten years.
- Revise the Systems Walkdown Procedure to add a trending section to require degradation to submerged concrete observed during periodic under water inspections at the Dam Spillway to be used as a leading indicator for potential degradation to other below grade concrete structures in the scope of LR.

The NRC RG 1.127 and GALL XI.S7 recommend special inspections immediately following the occurrence of significant natural phenomena, such as large floods, earthquakes, hurricanes, tornadoes, and intense local rainfalls. Special inspection of the Robinson dam was inspected following the 2011 Virginia earthquake. This is consistent with the GALL XI.S7. The staff determined during the audit that the program appears effectively in addressing aging management of the RNP water-control structures and the overall program as implemented meets GALL Rev. 2 AMP XI.S6.

5.3.6.3 Recommendations for Subsequent License Renewal

5.3.6.3.1 Good Practices or Strengths of the AMP

A section is added to the plant procedure TMM-104 (System Walkdown Procedure) which requires trending the degradation of the submerged concrete observed during periodic underwater inspections at the Dam Spillway and uses it as a leading indicator for

potential degradation to other below grade concrete structures in the scope of RNP license renewal. The use of degradation of submerged structures as a leading indicator for potential degradation to other below grade concrete structures in the scope of license renewal is considered as strength of the AMP.

RNP conducts System Health report in a quarterly basis. It is considered as a good practice. The reports provide valuable insights on the conditions of the RNP water-control structures. The RNP quick hit self-assessment was performed in accordance with the plant License Renewal Implementation Procedure, requires performing periodic assessments of LR commitments and aging management activities at least once every three years. These assessments shall meet the following requirements:

- Review credited preventive maintenance activities to ensure they are being performed and meet the requirements of LR commitments and aging management programs.
- Review credited procedures to verify they accurately reflect commitments and aging management programs.
- Review License Renewal Aging Management Activities and Program Implementation Plans to verify they accurately reflect the status of LR commitment and aging management program implementation.
- Determine the overall status of committed actions.
- Review and incorporate applicable OpE into the implementation of the assigned aging management program or commitment.

Due to resource limitations, the quick hit self assessment reviewed only a sample of the aging management programs based on the prioritization. The following AMPs were reviewed, and their program owners interviewed:

- Nickel Alloy Nozzles and Penetrations
- Fire Protection and Fire Water Programs
- Dam Inspection Program
- Steam Generator Tube Integrity
- Bus Duct Aging Management Program
- Fatigue Monitoring Program
- Open Cycle Cooling Water Program
- Preventive Maintenance Program
- Boric Acid Corrosion Program
- Flow Accelerated Corrosion Program
- Reactor Vessel Internals Program

Even though, not all AMP programs were covered in the quick self-assessment, the staff considers the RNP periodic self-assessment of AMP is a good practice and is recommended to all applicants.

S6.S-1: *Recommendation*: It is recommended in GALL using degradation of concrete in the submerged strictures as a leading indicator for potential degradation to other below-grade concrete structures in the scope of license renewal such as below-grade

containment concrete.
***Technical Basis*:** Submerged structures can be periodically inspected by underwater diver without excavation. Degradation of concrete in the submerged structures would indicate potential degradation to other below-grade concrete in the scope of RNP license renewal such as below-grade containment concrete.

S6.S-2: *Recommendation*: It is recommended in GALL including performing system health report in a quarterly basis.
***Technical Basis*:** System Health report performed quarterly could provide detection of aging effects in a timely manner.

S6.S-3: *Recommendation*: Including periodic self-assessment of LR commitments and aging management activities in GALL.
***Technical Basis*:** The AMP self-assessment would ensure the LR commitment and aging management activities have been accurately implemented.

5.3.6.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S6.0-1: *Recommendation*: This AMP should be continuously rated a High priority for future AMP audits.
***Technical Basis*:** Based on Fukushima experience, flooding due to failure of water-control structures such as dam, spillway could cause severe consequence of plant safety.

1. Scope of Program:

The program include inspection of concrete structures, embankments, spillways, outlet works (gates, channels, sluices, etc.).
Spillway Structures
- Control Gates and Operating Machinery
- Unlined Saddle Spillways
- Approach and Outlet Channels

Outlet Works
- Intake Structure
- Operating and Emergency Control Gates
- Conduits, Sluices, Water Passages, Etc.
- Approach and Outlet Channels

2. Preventive Action:

The RNP program is an inspection program and no actions are taken as part of this program to prevent or mitigate aging degradation.

The GALL XI.S7 is augmented to incorporate preventive measures recommended in NUREG-1339, EPRI TR-104213, EPRI NP-5067, and EPRI NP-5769 to ensure structural bolting integrity, if applicable. The documents provide guidelines for selection of replacement bolting material, approved thread lubricants, and appropriate torque and preload to be used for installation of bolting. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and SCC potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication “Specification for Structural Joints Using ASTM A325 or A490 Bolts” should be used. The RNP program may need to include preventive measures for anchor bolting to be consistent with GALL XI.S7.

3. Parameters Monitored/Inspected:

The parameters monitored/ inspected of concern in the program include:

Steel Structures Aging Effects/Mechanisms:
- Loss of Material due to Crevice Corrosion
- Loss of Material due to General Corrosion
- Loss of Material due to Pitting Corrosion
- Loss of Material due to MIC

Earthen Structures Aging Effects/Mechanisms:
- Loss of Form due to Settlement

Concrete Structures Aging Effects/Mechanisms:
- Loss of Material due to Aggressive Chemical Attack
- Loss of Material due to Corrosion of Embedded Steel
- Change in Material Properties due to Aggressive Chemical Attack

4. <u>Detection of Aging Effects</u>:

Lake water at RNP site is aggressive (low pH value). Periodic monitoring (semi-annual) of below-grade water chemistry (including consideration of potential seasonal variations), are performed to demonstrate that the below-grade environment is not aggressive.

The RNP program consists of bi-monthly, yearly, 5-year and 10-year inspections of the RNP water-control structures. Unit 2 maintenance personnel in conjunction with Unit 1 Operations personnel perform routine bi-monthly inspections and maintenance on mechanical systems, and components including lubricating mechanical components and operating the tainter gates of the spillway. The earthen embankment is inspected annually in accordance to USACE standards. Structural inspection of the concrete and above water portion of the dam is performed on a 5-year frequency. The inspections are performed in accordance with the recommended guidelines for a Phase I dam safety inspection in the “Recommended Guidelines for Safety Inspection of Dams”. The submerged portion of the concrete spillway is inspected by divers on a frequency not to exceed 10 years. GALL Rev 2 AMP XI S.7 recommends that all portions of the Dam be inspected on a 5-year frequency. The 10-year inspection interval for the submerged spillway concrete was accepted in the RNP SER (NUREG-1785) for license renewal.

During the audit, the RNP engineer stated that visual observations of the physical condition are used to judge if settlement of the embankment has occurred.

S6.4-1: *Recommendation*: GALL states that In general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. It is recommended to increase the frequency of ground water sampling in GALL from “not to exceed 5 years” to “semi-annual” or “quarterly”.
***Technical Basis*:** RNP performs periodic monitoring of below-grade water chemistry on semi-annual basis for capturing potential seasonal variations to demonstrate that the below-grade environment is not aggressive.

5. <u>Monitoring and Trending</u>:

The ground water and lake water at the dam site is monitored twice a year for pH, chlorides and sulfates. Recent (2011) Lake Water Trending results are:

2011 Mean pH: 6.6
2011 Mean Chlorides: 3.20 PPM
2011 Mean Sulfates: 3.20 PPM
These values are in the acceptable range per GALL Rev 2 AMP XI S7

As mentioned above, the Aging Management Commitment 27 includes:
"Establish trending requirements for structures based on aggressive ground water and lake water".

RNP implements the trending and evaluation of lake water and ground water in following requirements in plant procedure, Condition Monitoring of Structures:

- Groundwater and lake water monitoring results (pH, chlorides, sulfates) will be reviewed by Engineering and trended. Increasing aggressiveness of the groundwater and lake water will be used as a leading indicator for potential degradation to below grade concrete structures in the scope of License Renewal.
- Degradation to below grade concrete exposed during excavation will be used as a leading indicator for potential degradation to remaining below grade concrete structures in the scope of License Renewal.
- Engineering will evaluate if the leading indicators for potential degradation to concrete are or are not common to other structures in the scope of License Renewal (including ASME Section XI, Subsection IWL), and shall initiate appropriate corrective actions.

S6.5-1: Recommendation: Consider use "increasing aggressiveness of the groundwater/lake water" as a leading indicator in GALL for potential degradation to below grade concrete structures in the scope of License Renewal.
Technical Basis: Increasing aggressiveness of the groundwater/lake water n would indicate potential degradation for all below-grade concrete structures in the scope of License Renewal.

S6.5-2: Recommendation: Consider in GALL in using "degradation to below-grade concrete exposed during excavation" as a leading indicator for potential degradation to remaining below grade concrete structures.
Technical Basis: Degradation to below-grade concrete exposed during excavation would indicate potential degradation to remaining below grade concrete structures.

6. <u>Acceptance Criteria</u>:

Acceptance criteria for the results of inspection and monitoring are in accordance with the requirements in the "Recommended Guidelines for Safety Inspection of Dams". The plant Condition Monitoring of Structures procedure requires:

- Water-retaining structures should not have areas of differential settlement or construction joint gaps that allow water to leak beneath the structure thereby causing soil erosion and concrete deterioration. Concrete cracking around spillway gates of dams may be due to high hydrostatic forces, differential settlement, and lack of maintenance.

7. Corrective Actions:

A two phase approach of corrective actions is implemented in accordance with the guidelines in the “Recommended Guidelines for Safety Inspection of Dams”. Phase I performs a detailed field inspection. Phase II investigation is supplementary to Phase I and is conducted when the results of the Phase I investigation indicate the need for additional in-depth studies, investigations or analyses. The System Walkdown Procedure requires the responsible system engineer to review the Walkdown report and initiate corrective actions for any unacceptable attributes identified during the inspection.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

An inspection of the inaccessible areas of the submerged portions of the intake structure was performed in1999, using divers and video equipment. The concrete located at the water line showed signs of erosion from the constant wave action. The top coat of mortar has eroded away leaving the aggregate exposed. The average loss of cover is approximately 1/16 inch to 1/8 inch.

An underwater inspection of the submerged dam spillway was performed in 2000, by divers. A spalled portion of concrete (6' by 8" by 4" deep) was identified. This area was repaired prior to the period of extended operation. No other underwater concrete degradation was identified.

The 2012 annual report and the 5-year (2010) inspection reports concluded that the Robinson dam is in good condition with no visible dips, sags, slumps, sinks or other evidence of distress.

Several quarterly Dam Safety program health reports were reviewed during the audit. It was noted that in 2011 and much of 2012 the program was “Red” mainly due to material condition of the spillway Tainter gates. Maintenance activities to address this are in progress and are planned to be completed in 2014. The current, 4th Q 2012, program status is “White” based on the work completed to date.

As mentioned above, special inspection of the Robinson dam was performed following the 2011 Virginia earthquake. During the audit, the inspection report was reviewed. No concerns were noted in the inspection report.

Recent annual (2012) and 5-year (2010) inspection reports were reviewed in the audit. The overall conclusion from the 2010 annual report was that “The H.B. Robinson Cooling Lake Dam is adequately designed and adequately constructed. It is in good condition with no visible dips, sags, slumps, sinks or other evidence of distress. The upstream rip rap is sound, and the downstream grass cover is well established. Maintenance of the dam by plant personnel is excellent, and the dam is routinely inspected by plant personnel. The 2012 annual inspection report had similar conclusions.

During the audit, the staff performed a cursory walkdown inspection of the Dam during the audit. The staff observed that, overall, the earthen embankment and the concrete structure at the spill way appear in good condition.

The RNP OpE and the staff’s walkdown during the audit indicate that the RNP Inspection of Water-Control Structures AMP appears to be effective in identifying and addressing aging-related problems.

5.3.7 Protective Coatings Monitoring and Maintenance (XI.S8)

5.3.7.1 Objective and Scope of the AMP

A recent improvement to the RNP containment coatings program included the development of procedure "Primary Containment Coatings Condition Assessment," which replaced a site procedure previously utilized to conduct assessments. The purpose of the procedure is to perform a condition assessment of protective coatings inside the containment during each refueling outage to identify and quantify coatings degradation of unqualified coatings. The RNP coating assessment procedures incorporate the GSI-191 bases and requirements for evaluating and tracking unqualified coatings in the containment. The RNP Primary Containment Coating Condition Assessment Program was developed to satisfy GL 98-04 and GL 2004-02. RNP considers this program consistent with the GALL XI, S8 and ASTM D5163.

5.3.7.2 Effectiveness of the AMP to Meet Its Objective

The audit report on the assessment of AMP effectiveness from a visit to RNP was reviewed to extract relevant information for evaluating the effectiveness of the AMP implementation. The criteria for the evaluation were described in Chapter 3. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below.

5.3.7.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. The significant results of an assessment of the adequacy of the program description are as follows:

The RNP-2's Primary Containment Coating Condition Assessment procedure was developed with the goal of identifying protective coatings that have degraded to the point that they are no longer considered qualified for design basis accident conditions. When that occurs, then repairs can be scheduled and performed. The program description was found to be satisfactory.

5.3.7.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

Based on reviewing similar procedures at other licensees, the staff felt that the RNP-2 coating procedure "Primary Containment Coating Condition Assessment," appears to be adequate and consistent with GALL AMP XI.S8.

5.3.7.3 Recommendations for Subsequent License Renewal

5.3.7.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.3.7.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

S8.0-1: Recommendation: This AMP is rated a Medium priority for future AMP audits. **Technical Basis:** The licensee have improved their containment coating program significantly over years for compliance with GL 98-04, GL 2004-02 and GSI-191. The containment coating program is considered to be stable and effective.

1. Scope of Program:

RNP plant procedure requires performing a condition assessment of protective coatings inside the containment during each refueling outage to identify and quantify coatings degradation.

2. Preventive Action:

The RNP program is an inspection, monitoring, and condition assessment program and no actions are taken as part of this program to prevent or mitigate aging degradation.

3. Parameters Monitored/Inspected:

Aging effects such as blistering, cracking, flaking, rusting, and insufficient adhesion of coatings are monitored.

4. Detection of Aging Effects:

The interior of the RNP containment is lined with steel plates that are welded together. The liner plate covers the dome, cylinder walls, reactor sump, and the base slab and forms a leak proof membrane. The liner is not relied upon for the structural integrity of the containment except for resisting tangential shears in the dome. The inside surface of the liner plate was originally coated with a zinc-rich primer and an alkyd top coat from elevation 228 ft. to approximately elevation 352 ft. Above this, the inside surface of the liner was coated with a zinc based primer and phenolic epoxy topcoat. The liner plate is protected by insulation and sheathing. The liner is insulated from the lowest floor level, up to the spring line of the cylindrical shell. The insulation is not normally removed to inspect the coatings behind it. Inspection behind the insulation is on an opportunistic basis.

The condition assessments are conducted each refueling outage. The training and qualification requirements of the personnel performing the inspections are listed in the procedure. The process that the supervisor would use to train a new coating program owner was discussed in the audit. The supervisor stated that he would use the RNP-2/Duke Training and Qualification program and rely on mentoring from qualified coatings personnel at other sites.

5. Monitoring and Trending:

Monitoring of containment coatings is conducted, at a minimum, once each fuel cycle in accordance with procedures and preventative maintenance (PM) requirements. Monitoring involves conducting a general visual examination of assessable coated surfaces within the containment, followed by additional nondestructive and destructive examinations of degraded coating areas as directed by the plant Coatings Program Manager. Examinations of degraded coating areas are conducted by qualified personnel.

Detailed instructions on conducting coating examinations, including deficiency reporting criteria and documentation requirements are contained in the plant procedures. The RNP program and site procedure "Containment Building Coatings Exemption Requests" incorporate GSI-191 bases and requirements for evaluating and tracking unqualified coatings in the containment.

6. <u>Acceptance Criteria</u>:

EGR-NGGC-0023 specifies a 100% walk-through of containment to visually assess the condition of the protective coatings. Coatings are considered to be acceptable, provided none of the following conditions are observed:

- Blistering greater than size No. 6 (Medium) as specified in ASTM D714
- Cracking greater than standard No. 6 as specified in ASTM D661
- Flaking greater than standard No. 6 as specified in ASTM D772
- Rusting equal to or greater than Grade 7 as specified in ASTM D610
- Insufficient adhesion, as determined by the Coating Program Manager
- Unqualified coatings.

Unqualified coatings have at least one of the following attributes:

- Cannot be attested to having passed the required laboratory testing, including irradiation and simulated Design Basis Accident
- On vendor-supplied items which are not procured with a qualified coatings system or it is not practical to be recoated in accordance with Service Level I requirements
- Does not meet the manufacturer's approved quality assurance program
- Coating was improperly applied or applied by an unqualified applicator
- Exhibits unacceptable defects at any time after installation
- Certifications are not available on material or applicator
- Coatings Application Reports are not available
- Inspections were performed by an unqualified person
- Inaccessible to repair, coat, or inspect
- Existing coatings degraded while in service and has not or cannot be removed, repaired, replaced, or evaluated to an acceptable status
- Cannot be evaluated as acceptable to plant licensing basis requirements.

Coatings in RNP containment are safety-related and applied as Service Level I unless specifically exempted otherwise. Some protective coatings in containment have been classified as unqualified coatings. These unqualified coatings are documented in plant calculation "Containment Unqualified Coatings." The unqualified coatings are periodically monitored, and assessed to assure that these coatings do not adversely affect the safety-related performance of the ECCS during post-LOCA recirculation.

S8.6-1: Recommendation: The RNP program provides a comprehensive list of attributes of unqualified containment coating that are monitored and accessed by the coating program. It is recommended in GALL to include these attributes.

Technical Basis: The attributes are comprehensive.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

Primary Containment Coating Condition Assessment procedure was issued in September 2012 to address deficiencies and recommendations identified in a RNP self-assessment. This procedure revision includes guidance from new or updated ASTM standards and an EPRI document. It also includes site commitments from GLs 98-04 and 2004-02. A self-assessment was also conducted in 2010. Based on a review of the RNP program procedures and OpE, the RNP-2 coating procedure appeared to be adequate, and that when implemented would ensure timely detection of degraded coatings.

5.4 AMPs for Electrical Systems

5.4.1 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (XI.E1)

5.4.1.1 Objective and Scope of the AMP

The objective of this AMP is to provide reasonable assurance that the intended function of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse local environments caused by heat, radiation or moisture will be maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

5.4.1.2 Effectiveness of the AMP to Meet Its Objective

The audit reports from the visit to RNP were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent operation. The potential areas for further consideration are classified into the "program description" and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection A.1, "XI.E1 Cables and Connections." The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 5.4.1.3.

5.4.1.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. . The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated. The definition of accessible may need further clarification.

5.4.1.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are:

5.4.1.3 Recommendations for Subsequent License Renewal

5.4.1.3.1 Good Practices or Strengths of the AMP

E1.S-1: *Recommendation*: Based on the staff effectiveness audits, the applicant's Electrical Cables and Connections Not Subject to 10 CFR 50.49 EQ Requirements program is capable of identifying adverse localized environments and identifying affected in-scope cables during the period of extended operation. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results.
Technical Basis: Program was not limited to sample area, but inspected all accessible cables in walkdown areas, including cables located in adverse localized environments and the identification of cables located in newly identified adverse localized environments. Greater scope than GALL Revision 2 – propose that XI.E1 be revised to ensure that adverse localized environments are identified for cable/connections. No cable degradation noted in documents reviewed. However, potential adverse environments identified (steam lines, high bay lighting) in proximity to cable tray and raceway were noted in photos taken during walkdowns.

5.4.1.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

The Non-EQ Insulated Cables and Connections Aging Management Program includes accessible (i.e. able to be approached and easily viewed) insulated cables and connections installed in structures (i.e. areas) within the scope of license renewal. This program includes cables and connections installed in an adverse, localized environment, caused by heat or radiation in the presence of oxygen, as well as other plant areas. An adverse, localized environment is defined as a condition in a limited plant area that is significantly more severe than the specified service condition for the cable or connection. It is noted that moisture is not specified as an adverse localized environment, inconsistent with GALL revision 2.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

Engineering will perform an evaluation on accessible insulated cables and connections when acceptance criteria are not met, in order to ensure that the license renewal intended functions will be maintained consistent with the current licensing basis. Such an evaluation is to consider the age and operating environment of the component, as well as the severity of the anomaly, and whether such an anomaly has previously been correlated to degradation of conductor insulation or connections. Corrective actions may include, but are not limited to, testing, shielding or otherwise changing the environment, relocation, or replacement of the affected cable or connection. Implementation of this AMP resulted in the identification of potential adverse localized environments in two areas, resulting in more frequent inspections planned for these areas.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.4.2 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits (XI.E2)

5.4.2.1 Objective and Scope of the AMP

The objective of this AMP is to provide reasonable assurance that the intended functions of electrical cables and connections (that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are used in instrumentation circuits with sensitive, high-voltage, low-level current signals exposed to adverse localized environments caused by temperature, radiation, or moisture) are maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a performance monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

5.4.2.2 Effectiveness of the AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to Robinson were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent operation. The potential areas for further consideration are classified into the “program description” and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection B.32 XI.E2. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP-LR), are listed in Subsection 5.4.2.3.

5.4.2.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E2 may need to be evaluated. The definition of accessible may need further clarification.

5.4.2.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

5.4.2.3 Recommendations for Subsequent License Renewal

5.4.2.3.1 Good Practices or Strengths of the AMP

E2.S-1: *Recommendation*: Based on the staff effectiveness audits, the applicant's counterpart to XI.E2 program is capable of identifying adverse localized environments and identifying affected in-scope cables during the period of extended operation. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results.

5.4.2.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

Neutron Flux Instrumentation Circuits: The RNP's refueling outage 25 test results indicated a decrease in the insulation resistance between the inner shield and the outer shield for the cable inside containment from the results taken at the beginning of refueling outage 24. The N-32 detector was replaced at the end of refueling outage 24. The licensee indicated that the lower insulation resistance values were likely the result of a very small amount of moisture from the containment atmosphere that became trapped in the connection between the detector and the field cable during the detector replacement. The refueling outage 26 test results demonstrated a return to normal insulation resistance values, confirming that the lower insulation resistance was due to moisture which has since dried out. Based on this information, the licensee concluded that the condition monitoring testing has not shown an adverse trend in insulation resistance that would be indicative of cable degradation.

5.4.3 Inaccessible Power Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (XI.E3)

5.4.3.1 Objective and Scope of the AMP

The objective of this AMP is to provide reasonable assurance that the intended functions of inaccessible or underground power cables that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to wetting or submergence are maintained consistent with the current licensing basis through the period of extended operation. As stated in GALL Rev. 2, this is a condition monitoring program. However, periodic actions are taken to prevent inaccessible cables from being exposed to significant moisture, such as identifying and inspecting in-scope accessible cable conduit ends and cable manholes for water collection, and draining the water, as needed.

5.4.3.2 Effectiveness of the AMP to Meet Its Objective

The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent operation. The potential areas for further consideration are classified into the "program description" and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection B.33 XI.E3

. Based on the licensee's analysis of the GALL Rev 2, the licensee added (although not credited for license renewal) 480 volt safety related buried cable for the service water pumps, and the diesel generator fuel oil transfer pumps. The licensee performs service water cable tests on an 18-mo frequency and the diesel generator fuel oil transfer pump motors are tested on a one-yr frequency. Also, the licensee inspects the associated manholes on a 6-mo frequency. The licensee stated that there are no gaps between RNP's cable aging management program for inaccessible power cables and the GALL Rev2, XI.E3 AMP.

The licensee also stated in its industry operating experience evaluation that the underground medium voltage cables (circulating water pumps) are tested every 6 years and the replacement of these cables is scheduled. The licensee also indicated that the low voltage power cable for the service water pumps were replaced and installed in an above ground concrete cable tray. Also, the licensee stated that the diesel generator fuel oil transfer pump cables were replaced in 2003.

5.4.3.2.1 Adequacy of the Program Description

The Robinson Cable Aging Management Program includes inaccessible medium voltage cables (circulating water pump motors (4.16kV). Based on testing performed under this program, the 2C circulating water pump cable was replaced. In addition, based on test results the 2C pump test frequency was revised to 3 years, instead of the program's 6 year frequency. The program is also stated to include actions and preventive maintenance to maintain safety related and critical power cables from being in a submerged environment.

5.4.3.2.2 Effectiveness and Implementation of the AMP

Program heath reports reviewed by the staff have an overall status of red, based on not completing an assessment that all safety related cables and critical cables are being maintained in the environment for which they were qualified. Robinson received two non-cited violations for submerged cable issues.

5.4.3.3 Recommendations for Subsequent License Renewal

5.4.3.3.1 Good Practices or Strengths of the AMP

No specific good practice was identified during the review.

5.4.3.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

Based on the gap analysis performed by RNP, the licensee added (although not LR-credited) 480 volt safety related buried cable for the Service water pumps and Diesel Generator fuel oil transfer pumps. Service water cable tests are performed on an 18 month frequency. The Diesel Generator fuel oil transfer pump motors are tested on a one year frequency. The associated manholes are inspected on a 6 month frequency. The applicant claimed that there are no gaps between Robinson's cable aging management program for inaccessible power cable and GALL Report XI.E3 Revision 2.

2. Preventive Action:

Inspection frequencies at the plant are consistent with those recommended in GALL. Event driven inspections, inspection attributes, and dewatering systems were not addressed in the Gap analysis.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified

5.4.4 Metal-Enclosed Bus (XI.E4)

5.4.4.1 Objective and Scope of the AMP

The objective of this AMP is to provide an internal and external inspection of Metal Enclosed Buses (MEBs) to identify age-related degradation of insulating material (i.e., porcelain, xenoy, thermoplastic organic polymers), and metallic and elastomer components (e.g., gaskets, boots, and sealants). As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

5.4.4.2 Effectiveness of the AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to Robinson were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent operation. The potential areas for further consideration are classified into the “program description” and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection B.34 XI.E4. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 5.4.4.3.

5.4.4.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on internal and external inspection of Metal Enclosed Buses (MEBs) to identify age-related degradation of insulating material (i.e., porcelain, xenoy, thermoplastic organic polymers), and metallic and elastomer components (e.g., gaskets, boots, and sealants).

5.4.4.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

5.4.4.3 Recommendations for Subsequent License Renewal

5.4.4.3.1 Good Practices or Strengths of the AMP

E4.S-1: *Recommendation*: Based on the staff effectiveness audit at Robinson, the applicant's counterpart to XI.E4 is capable of inspecting the material and components internal to in-scope non-segregated bus duct. Visual inspection should be included as parts of inspection of bolted connection covered by heat shrink as well as uncovered bolted connections. The visual inspection could be used to detect broken washers, as well as corrosion of bolted connections.
Technical Basis: All bolted connections should be inspected, instead of a sample of bolted connections. Visual inspection should be considered for uncovered bolted connection, as well as resistance measurement or thermography. If thermography is considered, a window on the bus duct should be installed, because the cover of bus duct will mask any heat rise.

5.4.4.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

All bolted connections should be inspected, instead of a sample of bolted connections. Visual inspection should be considered for uncovered bolted connection as well as resistance measurement or thermography. If thermography is considered, a window on the bus duct should be installed, because the cover of bus duct will mask any heat rise above the ambient temperature.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

The licensee identified heat related degradation of tapped bolted connections broken and loose bolted connections on Bus Duct E2. The licensee indicated that no sign of damage or wear was found on the bus duct enclosure. Also, the licensee did not find any rust indications on the surface of interior of the Bus Duct E2. The licensee revised a work order to repair the broken lock washers.

5.4.5 Fuse Holders (XI.E5)

5.4.5.1 Objective and Scope of the AMP

The objective of this AMP is to provide reasonable assurance that the intended function of the metallic clamps of fuse holders are maintained consistent with the current licensing basis through the period of extended operation. It manages fuse holders (metallic clamps) located outside of active devices that are considered susceptible to the following aging effects: increased resistance of connection due to chemical contamination, corrosion, and oxidation or fatigue caused by ohmic heating, thermal cycling, electrical transients, frequent manipulation, or vibration. Fuse holders inside an active device (e.g., switchgear, power supplies, power inverters, battery chargers, and circuit boards) are not within the scope of this AMP. As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.

5.4.5.2 Effectiveness of the AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to Robinson were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent operation. The potential areas for further consideration are classified into the “program description” and the ten (10) program elements of the AMP. The information gathered from the plant visits and its assessment is included in Appendix Subsection B35 XI.E5. The significant results related to the adequacy of the program description and the effectiveness and implementation of the AMP are summarized below. The recommendations for subsequent license renewal, its technical basis, and the related section in the GALL Report and/or standard review plan (SRP), are listed in Subsection 5.4.1.3.

5.4.5.2.1 Adequacy of the Program Description

The adequacy of the program description was evaluated against the criteria described in Chapter 3. This program depends on testing at least once every 10 years to provide an indication of the condition of the metallic clamp of the fuse holder. Testing may include thermography, contact resistance testing, or other appropriate testing methods.

5.4.5.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation were evaluated against the criteria described in Chapter 3. The significant results of the evaluation are as follows:

5.4.5.3 Recommendations for Subsequent License Renewal

5.4.5.3.1 Good Practices or Strengths of the AMP

E5.S-1: *Recommendation*: Based on the staff effectiveness audits, on applicants' counterparts to the Fuse Holders AMP, suggestions were made that visual inspection should be included as part of inspection of fuse holders as well as thermography. ***Technical Basis:*** The licensee used fuse clip thermography to confirm the absence of thermal fatigue in the form of high resistance caused by ohmic heating, thermal cycling or electrical transients, mechanical fatigue caused by frequent manipulation of the fuse or vibration, chemical contamination, corrosion and oxidation. Based on this survey, the licensee concluded that Shutdown Panel Diesel Generator Fuses are in good working order.

5.4.5.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

5.4.6 Electrical Cable Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (XI.E6)

5.4.6.1 Objective and Scope of the AMP

The objective of this AMP is to provide reasonable assurance that the intended function of the metallic parts of electrical cable connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and susceptible to age-related degradation resulting in increased resistance of connection due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation are maintained consistent with the current licensing basis through the period of extended operation. Cable connections associated with cables within the scope of license renewal that are external connections terminating at active or passive devices, are in the scope of this AMP. Wiring connections internal to an active assembly are considered part of the active assembly and, therefore, are not within the scope of this AMP. This AMP does not include high-voltage (>35 kilovolts) switchyard connections. The cable connections covered under the Environmental Qualification (EQ) program are not included in the scope of this program. As stated in GALL Rev. 2, this is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation. As Robinson is a GALL Rev. 0 unit, there is no AMP XI.E6. There was no formal AMP effectiveness audit and there was no worksheet completed in Appendix B.

5.4.6.2 Effectiveness of the AMP to Meet Its Objective

N/A

5.4.6.3 Recommendations for Subsequent License Renewal

N/A

5.4.7 Environmental Qualification of Electrical Equipment (TLAA X.E1)

5.4.7.1 Objective and Scope of the AMP

The objective of EQ AMP program is to manage thermal, radiation and cyclical aging for electrical equipment. For license renewal, plant EQ programs that implement the requirements of 10 CFR 50.49 are considered AMPs for license renewal. Under 10 CFR 54.21(c) (1)(iii), the effects of aging on the intended functions will be adequately managed for the period of extended operation. Reanalysis of the EQ program aging evaluation completed under 10 CFR 50.49(e) is part of the EQ program. The aging reanalysis considered important attributes including analytical method, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions. If the qualification of component cannot be extended, that component is refurbished, replaced, or re-qualified prior to exceeding the current qualification term (qualified life).

5.4.7.2 Effectiveness of the AMP to Meet Its Objective

The audit reports on the assessment of AMP effectiveness from a visit to Robinson were reviewed to extract relevant information for evaluating the effectiveness or implementation of the AMP. The evaluation of the effectiveness of the AMP is divided into two parts: (a) assessing the AMP adequacy and (b) evaluating results of the AMP implementation; the criteria for the evaluation are described in Chapter 3. The information was reviewed to identify good practices or strengths of the AMP and potential areas of the AMP that may require further consideration or enhancements for subsequent operation.

The Robinson EQ program maintains the qualified life of the electrical equipment important to safety within the scope of 10 CFR 50.49, “Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants." An aging limit (qualified life) is established for equipment within the scope of the Robinson EQ program and an appropriate action, such as replacement or refurbishment, is taken prior to or at the end of the equipment qualified life so that the aging limit is not exceeded.

The Robinson EQ program activities establish, demonstrate, and document the level of qualification, qualified configuration, maintenance, surveillance, and replacement requirements necessary to meet the requirements of 10 CFR 50.49. The Robinson EQ program includes maintenance of supporting documentation, such as input information, references, calculations, analyses, EQ related correspondence, qualification test reports, and certifications. Environmental qualification binders are maintained to demonstrate and document the qualified life of the equipment.

5.4.7.2.1 Adequacy of the Program Description

The adequacy of the program description was determined to be adequate.

5.4.7.2.2 Effectiveness and Implementation of the AMP

The effectiveness of the AMP and the results of the AMP implementation audits were evaluated and determined to be adequate. This program depends on site specific evaluations to verify thermal, radiation and cyclical aging for electrical equipment subject to 10 CFR 50.49 is being managed and in-scope equipment is replaced before the end of its qualified life.

5.4.7.3 Recommendations for Subsequent License Renewal

Consider the below six items for the TLAA in general. These issues should be considered in the context of SLR.

1) Methodologies used to establish or evaluate an EQ component's qualified life, or to project qualified life and LOCA for subsequent license renewal performance, should be reviewed to confirm applicability, and that adequate margin is maintained.
2) The use of plant data (temperature and radiation), instead of design values, and the methodology used to acquire and evaluate these parameters, varies by applicant.
3) For subsequent license renewal (60 to 80 years), establish that current methods to project qualified life and ensure LOCA EQ for electrical components provide adequate margin, or maintain EQ for PEO.
4) It may be useful to determine if there were any major plant modifications, or events of sufficient duration, to cause the temperature and radiation values used in the underlying assumptions in the EQ calculations to be exceeded.
5) An evaluation that addresses the controls used to monitor changes in plant environmental conditions, to periodically validate the environmental data used in analyses.
6) Wear cycle aging may be a factor for some equipment within the EQ program. A wear cycle aging effect may be applicable to motors, limit switches, and connectors, and other electrical components for the period of extended operation.

5.4.7.3.1 Good Practices or Strengths of the AMP

***Recommendation*:** Based on the staff effectiveness audits, and the applicants' counterpart to AMP X.E1 there are no recommended enhancements to this AMP.

5.4.7.3.2 Areas of the AMP for Further Consideration/Enhancement

Program Description:

No further review item identified.

1. Scope of Program:

No further review item identified.

2. Preventive Action:

No further review item identified.

3. Parameters Monitored/Inspected:

No further review item identified.

4. Detection of Aging Effects:

No further review item identified.

5. Monitoring and Trending:

No further review item identified

6. Acceptance Criteria:

No further review item identified.

7. Corrective Actions:

No further review item identified.

8. Confirmation Process:

No further review item identified.

9. Administrative Controls:

No further review item identified.

10. Operating Experience:

No further review item identified.

SECTION 6
Summary

An assessment of results from currently implemented license renewal AMPs has been performed to obtain a better understanding of the phenomena and management of certain materials degradation mechanisms, and to recommend improvements to the AMPs for subsequent license renewal beyond 60 years. The objective of such assessment is to obtain technical insights that would help in developing guidance documents for technical review of licensee submittals for SLR of NPPs. The overall approach to developing guidance documents for SLR involves compiling information relevant to aging degradation processes, the AMPs, and TLAAs currently being used to manage these aging effects for reactor operation up to 60 years, and evaluating the information, including the OpE, to (a) identify potential new aging degradation processes that may emerge during SLR; (b) assess the effectiveness of currently implemented programs; and (c) develop technical bases data and information for guidance to evaluate licensee-proposed management of the effects of aging adequate for SLR of nuclear power plants.

In this TLR, relevant information extracted from audit reports from visits to Ginna and NMP-1 plants and from reviews of NRC SERs for several LRAs, was evaluated to verify the effectiveness of several GALL Report AMPs in managing aging-related degradation of safety-significant structures and components, and to identify strengths as well as areas of the AMP that may require further consideration for SLR beyond 60 years. A total of 38 AMPs for mechanical systems, 10 AMPs for structural systems (including 2 plant-specific AMPs), 6 AMPs for electrical systems, and 2 AMPs associated with TLAAs have been evaluated. Information relevant for license renewal for SLR was compiled in separate worksheets for each AMP; all worksheets are included in Appendix A of this report. The review and evaluation of the information to examine the effectiveness of the AMPs was divided into two parts: (a) assessing the AMP efficacy and (b) evaluating results of the AMP implementation. The efficacy of the AMP was assessed on the basis of four aspects of the program: (a) management activities of the AMP, (b) clarity of the program description, (c) deviations from GALL program (i.e., exceptions or enhancements), and (d) good practices or strengths.

A generic evaluation of the information for the various AMPs was performed to identify the good practices or strengths of the AMPs and potential areas of the AMPs that may require further consideration or enhancements for SLR. The potential areas for further consideration associated with the “program description” and the ten program elements of the AMPs, are classified in three aspects of the AMP: (a) management activities, (b) clarity of program description, and (c) deviation from GALL program. The effects of plant modifications on GALL AMPs are also discussed.

To support the development of AMPs for LTO, a detailed evaluation is presented of the effectiveness of each of the GALL AMPs for mechanical systems and structural systems. The objective and scope of the program are first described to define which aging effects/degradation mechanisms combinations are being managed by the AMP. The structures and components covered by the AMP, including their material of construction, are also described. The different aging management activities that are being relied upon by the AMP to manage the potential effects of aging degradation are defined next. If the AMP is recommending guidance

delineated in other NRC or industry documents, these program basis or supporting documents and the specific guidance are clearly identified. Any restrictions or conditions for the applicability of the AMP are also defined.

The effectiveness of the AMP to meet its objective is assessed by examining (a) the adequacy of the program description and (b) the effectiveness and implementation of the AMP, using the approach and criteria discussed above. The significant results of the assessment are presented for each of the GALL AMPs. The consistency of the licensees AMP with the GALL AMP is also discussed. Finally, the recommendations for subsequent license renewal (i.e., beyond 60 years) and the technical basis are discussed in detail for all AMPs. The recommendations include good practices or strengths of the AMP and areas of the AMP, such as program description or the 10 program elements that require further consideration or enhancements.

The strength of the AMPs includes effective use of confirmation actions by performing corrective actions, root cause analyses, and review of plant OpE and health reports for periodic assessment and improvement of program effectiveness. Some examples of areas of the AMP that require further consideration include the program description of several AMPs that do not include the objective of the AMP (which aging effects caused by what degradation mechanism are being managed), and the scope of program that do not include the material of construction of the structures and components covered by the AMP. In addition, the GALL program descriptions are generally silent on the need for licensees to ensure that their AMPs remain in compliance with the most recent NRC-approved guidance, as described on p. XI.3 of GALL, Rev. 2 “Guidance on Use of Later Editions/Revisions of Various Industry Documents.” Furthermore, these updates should include the potential effects of plant modification such as EPU and the replacement of the reactor vessel head or steam generator.

SECTION 7
Recommendation for Information Needed from Future AMP Effectiveness Audits

In the course of the AMP review and AMP effectiveness audits of Ginna and NMP-1 plants, the following recommendations were identified for information needed from future AMP effectiveness audits.

Pre-audit Preparation:

1. Schedule audits at least 4 months apart so that the technical information (and logistics) can be thoroughly prepared.

2. Prior to the AMP effectiveness audits, thoroughly review the OpE for the SSCs for which the AMP claims to manage aging. Highlight any recurring problems or trends in problem areas. After reviewing CRs and whatever PBDs, procedures, and IRs available electronically (and after receiving back answers) prepare and send questions to help the prospective interviewees prepare their response. Try to structure site interviews to be more of a post-RAI follow-up.

3. Have a pre-audit group discussion of preliminary results to ensure that as much as possible all relevant information has been reviewed and that there is awareness of important information that may affect understanding of one or more AMPs.

4. Prior to plant audit, thoroughly reviewing the NRC Information Notices published during the past five years. Generally, these INs contain very useful information on events and OpE of SSCs. During the audit, discuss these INs with AMP owners. Also, review CR or inspection reports and trending analyses and prepare a list of topics for further discussion with the AMP owner during the audit.

5. Prior to plant audit, thoroughly review the commitments in Appendix A of SER and verify the status of the commitments whether the commitments are completed, implemented, or changes made during the plant visit. Note that most of the commitments should be implemented prior to PEO as stated in the SER. There are cases that commitments were changed or dropped through the 10 CFR 50.99 process.

6. Preferably the staff should provide preliminary questions for each AMP prior to the audit so that the AMP owner can prepare for the supporting documents that may be needed during the audit.

General Recommendations:

1. Whenever possible, ensure that the person being interviewed is the AMP owner.

2. Check the frequency and results of any self-assessment performed for the AMP. Does the AMP self-assessment demonstrate/confirm that any CRs or instances of the AMP's aging effects are not only captured in timely manner but that the frequency of occurrence has been trending down with service years?

3. Ask for a schedule of review and updates of AMPs and the criteria used to decide this schedule, and check if there are any requirements or recommendations for such review and updates of the AMP. Review the results of these assessments since the start of PEO. If none were performed or scheduled, review any new OpE, industry initiatives, changes in basis, or design modifications.

4. Check how the main AMP's interface with other supplemental AMPs, such as the use of water chemistry program to supplement the BWR stress corrosion cracking program or the use of buried and underground piping and tanks program to supplement the fire water system program, is being handled or managed to meet the objective of the main AMP.

5. Check for any impact of EPU on the aging effects managed by the AMP, and how such impact is confirmed or managed with/without any changes to the original AMP. Note that any impact of EPU on aging effects especially enhanced by the increased temperatures and neutron fluxes in the reactor vessel internals and related components, which has not been evaluated and confirmed for adequacy of being managed under the current GALL AMP.

6. Verify whether the licensee's AMP uses the basis or supporting documents referenced in the GALL AMP. If not, check that the LRA is listing it as an exception and provides justification.

7. Confirm the status of any commitments for AMP consistency, and how the licensee tracks it.

8. Verify any changes of design basis evaluation, baseline configuration and conditions.

Specific Recommendations:

1. Check if there have been any instance(s) of loose parts and/or associated damage, or unexpected locations/damage identified in the RCS and core internals, and what procedures, precautions, and practices, if any, are in place to ensure that such degradation does not occur or is adequately managed to maintain their required functionality.

2. Verify during the audit interview which revision of GALL was used as guidance in preparing the AMP and what editions of the technical guidance documents that are recommended in the GALL Report (including the ASME Code) are being used.

3. Thoroughly review the process for implementing the AMP in question.

4. For Water Chemistry Program, (1) request trending data ahead of audit: ECP, [chlorides], [sulfates], pH, conductivity, dissolved oxygen, Hydrogen/Oxygen molar ratios, solute concentration, (2) request strategic water plan availability for review well prior to audit date, along with access to supporting EPRI proprietary technical reports referenced in operating guidelines and/or strategic plan, and (3) request of a list of identified system components deemed as obsolete or end-of-life and scheduled for replacement or upgrade, along with current commitment lists (inclusive of both NRC/industry OpE commitments)

5. For ASME Section XI, Subsections IWE & IWL Inservice Inspection AMP: (1) check if moisture barrier has been inspected and replaced, (2) check and inquire about the condition of liner plate coating , (3) inquire about the qualifications of the inspectors performing concrete containment and liner plate general inspections in between and prior to Appendix J Type A test, (4) inquire about grease leakage from tendon ducts, and (5) verify the condition of piping exposed to environment that is used for pumping grease into tendons.

6. For the ASME Section XI Subsection IWF AMP, inquire about the condition of high-strength bolts and whether UT of these bolts is being performed.

7. The GALL Rev.2, 2010 no longer includes performance tests of fire pump in the scope of Fire Protection AMP. Verify whether performance test of fire pump is still performed in plant.

8. Verify plant OpE and aging management activities of ground water leakage/penetration, monitoring/trending, acceptance criteria, and corrective action and verify frequency of ground water sampling, test and trending results.

References

(See references at end of Appendices A and B for more plant-specific citations)

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Appendix A – Ginna and Nine Mile Point Unit 1:

Appendix A Archive of Information from Worksheets used during Nonregulatory AMP Audits to Evaluate GALL Rev. 2 AMPs for Possible Subsequent Renewal

The verbatim text of the relevant GALL, Rev. 2, AMPs is included in each of the following worksheets; all text in blue is directly transcribed from GALL, Rev. 2. The source of information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of ANL's general review of the AMP and the draft NRC AMP audit report. Audit participants and documents reviewed for the audit are included at the end of Appendix A in Supplemental Information/

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Contents

A.1 XI.M1 ASME Section XI Inservice Inspection, Subsections IWB, IWC, IWD

The verbatim text of the Generic Aging Lessons Learned (GALL), Rev. 2, aging management program (AMP) XI.M1, ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and Nine Mile Point-1 (NMP-1) plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Title 10 of the Code of Federal Regulations, 10 CFR 50.55a, imposes the inservice inspection (ISI) requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, for Class 1, 2, and 3 pressure-retaining components and their integral attachments in light-water cooled power plants. Inspection of these components is covered in Subsections IWB, IWC, and IWD, respectively, in the 2004 edition. The program generally includes periodic visual, surface, and/or volumetric examination and leakage test of all Class 1, 2, and 3 pressure-retaining components and their integral attachments. Repair/replacement activities for these components are covered in Subsection IWA of the ASME code. The ASME Section XI inservice inspection program, in accordance with Subsections IWB, IWC, or IWD, has been shown to be generally effective in managing aging effects in Class 1, 2, or 3 components and their integral attachments in light-water cooled power plants. 10 CFR 50.55a imposes additional limitations, modifications, and augmentations of ISI requirements specified in ASME Code, Section XI, and those limitations, modifications, or augmentations described in 10 CFR 50.55a are included as part of this program. In certain cases, the ASME inservice inspection program is to be augmented to manage effects of aging for license renewal and is so identified in the Generic Aging Lessons Learned (GALL) Report.		
a.1: The inservice inspection program is likely to include other considerations such as risk-informed ISIs, relief requests, and in the case of boiling water reactors (BWRs), some Boiling Water Reactor Vessel and Internals Project (BWRVIP) requirements. Relation and precedence of these considerations vis-à-vis the ASME Section XI ISI Program, if not clarified or clearly stated as part of the AMP (especially where overlap/conflict may occur or Section XI inspections scope is reduced) may impact the effectiveness and/or checking of the AMP.	This ASME Section XI ISI has been credited by several other AMPs/aging management reviews (AMRs) and is used to supplement many AMPs, with very broad scope and implications. Clarity and specific guidance on any allowed or approved deviations would strengthen both the implementation and effectiveness of this and other related AMPs.	Include requirements and/or specific guidance for interface with other approved ISI plans or deviations.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.2: The objective of this AMP is not clear from the program description. The title suggests that its primary focus/intent is to meet requirements of parts of ASME Section XI ISI. The description implies, without clearly stating so, that the primary focus/intent is to meet 10 CFR 50.55a inspection requirements. The ASME Section XI ISI program is for periodic examinations and tests, and existed prior to, and independent of, the license renewal that is to address the management of aging effects over the period of extended operation (PEO).	The objective of this program is to meet the 10 CFR 50.55a inspection requirements, as part of the license renewal requirements under 10 CFR 54.35. License renewal typically includes ASME Section XI ISI and related limitations, modifications, or augmentations for renewal period or actions. The AMP relies on the existing ASME Section XI ISI program structure and results of its periodic examinations and tests to help manage certain aging effects through the PEO. Inclusion of a list of the aging effects addressed by, and any exclusion to, the Section XI ISI of Class 1, 2, and 3 pressure-retaining components and their integral attachments should be of interest. This use of the ASME Section XI ISI activity is to support the implementation of 10 CFR 50.55a inspection requirements.	Review and revise the description and title for clarity, as needed.
a.3: From the program description, or other program elements, it is not clear if there is a requirement for updating the program, to reflect review by the Staff, every 10 years.	Due to potential changes in Code requirements, related nondestructive examination (NDE) technology, and limitations of Code Cases applicability, the program update and its review are essential parts of the AMP to ensure its effectiveness in the PEO.	Review the requirement and revise text.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP relies on the ASME B&PV Code Section XI, Subsections IWB, IWC, and IWD, with 10 CFR 50.55a conditions.		
b.1: Page 1-2 of the current GALL Report, Rev. 2, [NUREG 1801] states: "Pursuant to 10 CFR 50.55a (g)(4), a nuclear licensee is required to amend its current licensing basis (CLB) by updating its ASME Section XI edition and addenda of record to the most recently endorsed edition and addenda referenced in 10 CFR 50.55a one year prior to entering the next 10-year internal inservice inspection (ISI) for its unit." The reference to "10-year internal ISI" is not clear.	The "10-year <u>internal</u> ISI" is meant to be "10-year <u>interval</u> ISI."	Edit in the next revision of GALL report.
Program Consistency and Commitments		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
At Ginna, this AMP is based on Rev. 0 of GALL Report, and was prepared to meet the requirements of ASME Section XI, 1995 Edition and 1996 Addenda. The safety evaluation report (SER) for Ginna, like the license renewal application (LRA), noted that the program is consistent with GALL, Rev. 0, with no deviation, and that the program performs inspection, repair, and replacement in accordance with Subsections IWB, IWC, and IWD of ASME Section XI. At Nine Mile Point 1 (NMP-1) this program is based on ASME Section XI, 1989 Edition, with no Addenda and ASME Section XI, Appendix VIII, 1995 Edition through 1996 Addenda; the LRA noted the program is consistent with GALL (Rev. 0), with the exception of the GALL requirement to use the 1995 Code Edition through 1996 addenda. In addition, the NMP-1 program modifies the ASME Section XI requirements, as approved by NRC, for certain welds with risk-informed inspection per ASME Code Case N-578-1. The SER for NMP-1 found the original program to be acceptable, consistent with the exception. The NMP-1 Fourth 10-Year Inservice Inspection Plan was developed to meet the 2004 Edition of Section XI, making it consistent with GALL, Rev. 1.		
c.1: (NMP-1 plant audit) The requirement for updating programs with review and approval from the NRC, and of modifications to the ASME XI ISI, such as risk-informed inspections, needs to be noted in the GALL AMP, in order to make LRAs explicit and make the evaluation of basis and adequacy of plant implementation of the AMP apparent in its review.	Using various (approved) ASME Code Cases, including those for relief requests such as the risk-informed process, and relating updating requirements with review, although possibly covered under 10 CFR 50.55a, is significant in scope.	Revise the program description.
1. Scope of Program		
The ASME Section XI program provides the requirements for ISI, repair, and replacement of code Class 1, 2, or 3 pressure-retaining components and their integral attachments in light-water cooled nuclear power plants. The components within the scope of the program are specified in ASME Code, Section XI, Subsections IWB-1100, IWC-1100, and IWD-1100 for Class 1, 2, and 3 components, respectively. The components described in Subsections IWB-1220, IWC-1220, and IWD-1220 are exempt from the volumetric and surface examination requirements, but not exempt from visual exam requirements of Subsections IWB-2500, IWC-2500, and IWD-2500.		
1.1: The repair and replacement requirements are covered under Subsection IWA, which is not listed here. The program includes inservice testing of certain components for leakage.	Both the AMP title and most program elements have emphasized the IWB, IWC, and IWD subsections, as well as inspection activity; however, the AMP effectiveness also relies on effective use of the inservice testing and timely repair replacement activities.	Review for adding clarification of the scope.
2. Preventive Actions		
This is a condition monitoring program. It does not implement preventive actions. It does not rely on preventive actions.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2.1: This is primarily a program for specified inspections or needed subsequent inspections, with only marginal monitoring or condition monitoring aspects.	Confirmation or elaboration of the condition monitoring activity, if any, as focused under this AMP would be useful.	Review and/or revise element description.
3. Parameters Monitored/Inspected		
The ASME Section XI ISI program detects degradation of components by using the examination and inspection requirements specified in ASME Section XI Tables IWB-2500-1, IWC-2500-1, or IWD-2500-1, respectively, for Class 1, 2, or 3 components. The program uses three types of examination—visual, surface, and volumetric—in accordance with the requirements of Subsection IWA-2000. Visual VT-1 examination detects discontinuities and imperfections, such as cracks, corrosion, wear, or erosion, on the surface of components. Visual VT-2 examination detects evidence of leakage from pressure-retaining components, as required during the system pressure test. Visual VT-3 examination (a) determines the general mechanical and structural condition of components and their supports by verifying parameters such as clearances, settings, and physical displacements; (b) detects discontinuities and imperfections, such as loss of integrity at bolted or welded connections, loose or missing parts, debris, corrosion, wear, or erosion; and (c) observes conditions that could affect operability or functional adequacy of constant-load and spring-type components and supports. Surface examination uses magnetic particle, liquid penetrant, or eddy current examinations to indicate the presence of surface discontinuities and flaws. Volumetric examination uses radiographic, ultrasonic, or eddy current examinations to indicate the presence of discontinuities or flaws throughout the volume of material included in the inspection program.		
3.1: The latest ASME Code (2001 Edition in GALL, Rev. 1, and 2004 Edition in GALL, Rev. 2) Section XI IWB-2500 dropped the requirement of volumetric examination for pump casing welds. There is no basis document listed to support this change. In addition, ASME Code Case N481, which has been in use to support alternative examination for these welds, requires flaw tolerance evaluation.	The basis for dropping volumetric examination for pump casing welds, especially when it is required for the valve body welds (greater than 4" NPS), needs to be examined and/or documented. If no volumetric examination is required, then it is unclear how the Code Case N481 would be met.	Review and revise requirements for volumetric examination of pump casing welds for consistency and basis.
4. Detection of Aging Effects		
The extent and schedule of the inspection and test techniques prescribed by the program are designed to maintain structural integrity and		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
ensure that aging effects are discovered and repaired before the loss of intended function of the component. Inspection can reveal cracking, loss of material due to corrosion, leakage of coolant, and indications of degradation due to wear or stress relaxation (such as changes in clearances, settings, physical displacements, loose or missing parts, debris, wear, erosion, or loss of integrity at bolted or welded connections). Components are examined and tested as specified in Tables IWB-2500-1, IWC-2500-1, and IWD-2500-1, respectively, for Class 1, 2, and 3 components. The tables specify the extent and schedule of the inspection and examination methods for the components of the pressure-retaining boundaries. Alternative approved methods that meet the requirements of IWA-2240 are also specified in these tables. For boiling water reactors (BWRs), the nondestructive examination (NDE) techniques appropriate for inspection of vessel internals, including the uncertainties inherent in delivering and executing an NDE technique in a BWR, are included in the approved Boiling Water Reactor Vessel and Internals Project Report (BWRVIP-03).		
4.1: No significant concern or further review item was identified.		
5. Monitoring and Trending		
For Class 1, 2, or 3 components, the inspection schedule of IWB-2400, IWC-2400, or IWD-2400, respectively, and the extent and frequency of IWB-2500-1, IWC-2500-1, or IWD-2500-1, respectively, provides for timely detection of degradation. The sequence of component examinations established during the first inspection interval is repeated during each successive inspection interval, to the extent practical. If flaw conditions or relevant conditions of degradation are evaluated in accordance with IWB-3100, IWC-3100, or IWD-3000 and the component is qualified as acceptable for continued service, the areas containing such flaw indications and relevant conditions are reexamined during the next three inspection periods of IWB-2410 for Class 1 components, IWC-2410 for Class 2 components, and IWD-2410 for Class 3 components. Examinations that reveal indications that exceed the acceptance standards described below are extended to include additional examinations in accordance with IWB-2430, IWC-2430, or IWD-2430 for Class 1, 2, or, 3 components, respectively.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
Any indication or relevant conditions of degradation are evaluated in accordance with IWB-3000, IWC-3000, or IWD-3000 for Class 1, 2, or 3 components, respectively. Examination results are evaluated in accordance with IWB-3100 or IWC-3100 by comparing the results with the acceptance standards of IWB-3400 and IWB-3500, or IWC-3400 and IWC-3500, respectively, for Class 1 or Class 2 and 3 components. Flaws that exceed the size of allowable flaws, as defined in IWB-3500 or IWC-3500, are evaluated by using the analytical procedures of IWB-3600 or IWC-3600, respectively, for Class 1 or Class 2 and 3 components. Flaws that exceed the size of allowable flaws, as defined in IWB-3500 or IWC-3500, are evaluated by using the analytical procedures of IWB-3600 or IWC-3600, respectively, for		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Class 1 or Class 2 and 3 components.		
6.1: The listed acceptance criteria do not cover or address all inservice inspections – e.g., augmented by risk-informed program.	These other inspections may be performance based with acceptable criteria for expansion of scope and frequency of inspections.	Add clarification.
7. Corrective Actions		
Repair and replacement activities are performed in conformance with IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Because the ASME Code is a consensus document that has been widely used over a long period, it has been shown to be generally effective in managing aging effects in Class 1, 2, and 3 components and their integral attachments in light-water cooled power plants (see Chapter I of the GALL Report). Some specific examples of operating experience of component degradation are as follows: BWR: Cracking due to intergranular stress corrosion cracking (IGSCC) has occurred in small- and large-diameter BWR piping made of austenitic stainless steels and nickel alloys. IGSCC has also occurred in a number of vessel internal components, such as core shrouds,		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
access hole covers, top guides, and core spray spargers (U.S. Nuclear Regulatory Commission [NRC] Bulletin 80-13, NRC Information Notice [IN] 95-17, NRC Generic Letter [GL] 94-03, and NUREG-1544). Cracking due to thermal and mechanical loading has occurred in high-pressure coolant injection piping (NRC IN 89-80) and instrument lines (NRC Licensee Event Report [LER] 50-249/99-003-01). Jet pump BWRs are designed with access holes in the shroud support plate at the bottom of the annulus between the core shroud and the reactor vessel wall. These holes are used for access during construction and are subsequently closed by welding a plate over the hole. Both circumferential (NRC IN 88-03) and radial cracking (NRC IN 92-57) have been observed in access hole covers. Failure of the isolation condenser tube bundles due to thermal fatigue and transgranular stress corrosion cracking (TGSCC) caused by leaky valves has also occurred (NRC LER 50-219/98-014-00). PWR Primary System: Although the primary pressure boundary piping of PWRs has generally not been found to be affected by stress corrosion cracking (SCC) because of low dissolved oxygen levels and control of primary water chemistry, SCC has occurred in safety injection lines (NRC IN 97-19 and 84-18), charging pump casing cladding (NRC IN 80-38 and 94-63), instrument nozzles in safety injection tanks (NRC IN 91-05), control rod drive seal housing (NRC Inspection Report 50-255/99012), and safety-related stainless steel (SS) piping systems that contain oxygenated, stagnant, or essentially stagnant borated coolant (NRC IN 97-19). Cracking has occurred in SS baffle former bolts in a number of foreign plants (NRC IN 98-11) and has been observed in plants in the United States. Cracking due to thermal and mechanical loading has occurred in high-pressure injection and safety injection piping (NRC IN 97-46 and NRC Bulletin 88-08). Through-wall circumferential cracking has been found in reactor pressure vessel head control rod drive penetration nozzles (NRC IN 2001-05). Evidence of reactor coolant leakage, together with crack-like indications, has been found in bottom-mounted instrumentation nozzles (NRC IN 2003-11 and IN 2003-11, Supplement 1). Cracking in pressurizer safety and relief line nozzles and in surge line nozzles has been detected (NRC IN 2004-11), and circumferential cracking in stainless steel pressurizer heater sleeves has also been found (NRC IN 2006-27). Also, primary water stress corrosion cracking (PWSCC) has been observed in steam generator drain bowl welds inspected as part of a licensee's Alloy 600/82/182 program (NRC IN 2005-02). PWR Secondary System: Steam generator tubes have experienced outside diameter stress corrosion cracking (OGSCC), intergranular attack, wastage, and pitting (NRC IN 97-88). Carbon steel support plates in steam generators have experienced general corrosion. Steam generator shells have experienced pitting and stress corrosion cracking (NRC INs 82-37, 85-65, and 90-04).		
10.1: No significant concern or further review item was identified.		

References

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10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

BWRVIP-03, *BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI TR-105696 R1, March 30, 1999), Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation for BWRVIP-03, July 15, 1999.

NRC Bulletin 88-08, *Thermal Stresses in Piping Connected to Reactor Coolant System*, U.S. Nuclear Regulatory Commission, June 22, 1988; Supplement 1, June 24, 1988; Supplement 2, September 4, 1988; Supplement 3, April 4, 1989.

NRC Generic Letter 94-03, *Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors*, U.S. Nuclear Regulatory Commission, July 25, 1994.

NRC Bulletin 80-13, *Cracking in Core Spray Spargers*, U.S. Nuclear Regulatory Commission, May 12, 1980.

NRC Information Notice 80-38, *Cracking in Charging Pump Casing Cladding*, U.S. Nuclear Regulatory Commission, October 31, 1980.

NRC Information Notice 82-37, *Cracking in the Upper Shell to Transition Cone Girth Weld of a Steam Generator at an Operating PWR*, U.S. Nuclear Regulatory Commission, September 16, 1982.

NRC Information Notice 84-18, *Stress Corrosion Cracking in PWR Systems*, U.S. Nuclear Regulatory Commission, March 7, 1984.

NRC Information Notice 85-65, *Crack Growth in Steam Generator Girth Welds*, U.S. Nuclear Regulatory Commission, July 31, 1985.

NRC Information Notice 88-03, *Cracks in Shroud Support Access Hole Cover Welds*, U.S. Nuclear Regulatory Commission, February 2, 1988.

NRC Information Notice 89-80, *Potential for Water Hammer, Thermal Stratification, and Steam Binding in High-Pressure Coolant Injection Piping*, U.S. Nuclear Regulatory Commission, December 1, 1989.

NRC Information Notice 90-04, *Cracking of the Upper Shell-to-Transition Cone Girth Welds in Steam Generators*, U.S. Nuclear Regulatory Commission, January 26, 1990.

NRC Information Notice 91-05, *Intergranular Stress Corrosion Cracking in Pressurized Water Reactor Safety Injection Accumulator Nozzles*, U.S. Nuclear Regulatory Commission, January 30, 1991.

NRC Information Notice 92-57, *Radial Cracking of Shroud Support Access Hole Cover Welds, U.S. Nuclear Regulatory Commission*, August 11, 1992.

NRC Information Notice 94-63, *Boric Acid Corrosion of Charging Pump Casing Caused by Cladding Cracks*, U.S. Nuclear Regulatory Commission, August 30, 1994.

NRC Information Notice 95-17, *Reactor Vessel Top Guide and Core Plate Cracking*, U.S. Nuclear Regulatory Commission, March 10, 1995.

NRC Information Notice 97-19, *Safety Injection System Weld Flaw at Sequoyah Nuclear Power Plant*, Unit 2, U.S. Nuclear Regulatory Commission, April 18, 1997.

NRC Information Notice 97-46, *Unisolable Crack in High-Pressure Injection Piping*, U.S. Nuclear Regulatory Commission, July 9, 1997.

NRC Information Notice 97-88, *Experiences during Recent Steam Generator Inspections*, U.S. Nuclear Regulatory Commission, December 16, 1997.

NRC Information Notice 98-11, *Cracking of Reactor Vessel Internal Baffle Former Bolts in Foreign Plants*, U.S. Nuclear Regulatory Commission, March 25, 1998.

NRC Information Notice 2001-05, *Through-Wall Circumferential Cracking of Reactor Pressure Vessel Head Control Rod Drive Mechanism Penetration Nozzles at Oconee Nuclear Station*, Unit 3, U.S. Nuclear Regulatory Commission, April 30, 2001.

NRC Information Notice 2003-11, *Leakage Found on Bottom-Mounted Instrumentation Nozzles*, U.S. Nuclear Regulatory Commission, August 13, 2003.

NRC Information Notice 2003-11, Supplement 1, *Leakage Found on Bottom-Mounted Instrumentation Nozzles*, U.S. Nuclear Regulatory Commission, January 8, 2004.

NRC Information Notice 2004-11, *Cracking in Pressurizer Safety and Relief Nozzles and in Surge Line Nozzles*, U.S. Nuclear Regulatory Commission, May 4, 2004.

NRC Information Notice 2005-02, *Pressure Boundary Leakage Identified on Steam Generator Drain Bowl Welds*, U.S. Nuclear Regulatory Commission, February 4, 2005.

NRC Information Notice 2006-27, *Circumferential Cracking in the Stainless Steel Pressurizer Heater Sleeves of Pressurized Water Reactors*, U.S. Nuclear Regulatory Commission, December 11, 2006.

NRC Inspection Report 50-255/99012, Palisades Inspection Report, Item E8.2, Licensee Event Report 50-255/99-004, *Control Rod Drive Seal Housing Leaks and Crack Indications*, U.S. Nuclear Regulatory Commission, January 12, 2000.

NRC Licensee Event Report LER 50-219/98-014-00, *Failure of the Isolation Condenser Tube Bundles due to Thermal Stresses/Transgranular Stress Corrosion Cracking Caused by Leaky Valve*, U.S. Nuclear Regulatory Commission, October 29, 1998.

NRC Licensee Event Report LER 50-249/99-003-01, Supplement to Reactor Recirculation B Loop, *High Pressure Flow Element Venturi Instrument Line Steam Leakage Results in Unit 3 Shutdown Due to Fatigue Failure of Socket Welded Pipe Joint*, U.S. Nuclear Regulatory Commission, August 30, 1999.

NUREG-1544, Status Report: *Intergranular Stress Corrosion Cracking of BWR Core Shrouds and Other Internal Components*, U.S. Nuclear Regulatory Commission, March 1, 1996.

A.2 XI.M2 Water Chemistry

The verbatim text of GALL, Rev. 2, AMP XI.M2, "Water Chemistry", is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The main objective of this program is to mitigate loss of material due to corrosion, cracking due to stress corrosion cracking (SCC) and related mechanisms, and reduction of heat transfer due to fouling in components exposed to a treated water environment. The program includes periodic monitoring of the treated water in order to minimize loss of material or cracking. The water chemistry program for boiling water reactors (BWRs) relies on monitoring and control of reactor water chemistry based on industry guidelines contained in the Boiling Water Reactor Vessel and Internals Project (BWRVIP)-190 (Electric Power Research Institute [EPRI] 1016579). The BWRVIP-190 has three sets of guidelines: one for reactor water, one for condensate and feedwater, and one for control rod drive (CRD) mechanism cooling water. The water chemistry program for PWRs relies on monitoring and control of reactor water chemistry based on industry guidelines contained in EPRI 1014986 (PWR Primary Water Chemistry Guidelines-Revision 6) and EPRI 1016555 (PWR Secondary Water Chemistry Guidelines- Revision 7). The water chemistry programs are generally effective in removing impurities from intermediate and high flow areas. The Generic Aging Lessons Learned (GALL) report identifies those circumstances in which the water chemistry program is to be augmented to manage the effects of aging for license renewal. For example, the water chemistry program may not be effective in low flow or stagnant flow areas. Accordingly, in certain cases as identified in the GALL Report, verification of the effectiveness of the chemistry control program is undertaken to ensure that significant degradation is not occurring and the component's intended function is maintained during the period of extended operation. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system.		
a.1: The EPRI guidelines cited by GALL continue to provide the best available guidance on water chemistry control, but no operating experience is available to verify their continued effectiveness for operating periods beyond 60 years.	A one-time inspection program that samples the entire system should be considered prior to entering the period of extended operation (PEO) to verify the continued effectiveness of the EPRI water chemistry guidance in controlling corrosion, SCC, and fouling before extending operating periods beyond 60 years. The scope and extent of this inspection program should be based in large part on the plant-specific operating experience with respect to corrosion, SCC, and fouling in the systems and	Consider adding recommendation for a one-time inspection that samples the entire system prior

[1] Proposed action for NRC for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	components managed by this AMP. Additional periodic inspections may also be required if problems related to water chemistry develop during the PEO.	to entering into LTO.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in 10 CFR Part 50, Appendix B; Boiling Water Reactor Vessel and Internals Project (BWRVIP)-190 (Electric Power Research Institute [EPRI] 1016579) for BWR water chemistry; EPRI 1014986 (Rev. 6) for PWR primary water chemistry; and EPRI 1016555 (Rev. 7) for PWR secondary water chemistry. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0. The Ginna Water Chemistry Control Program (B2.1.37) cites EPRI TR-105714 (Rev. 4) for primary systems chemistry and EPRI TR-102134 (Rev. 5) for secondary systems chemistry. In the amended NMP-1 LRA, the Water Chemistry Control Program (B2.1.2) cites EPRI TR-103515 (Rev. 1 and 2) for BWR water chemistry.		
b.1: The water chemistry standards cited in GALL are periodically updated, and the standards in use by the applicant at the time the plant AMP was prepared will probably not be current at the time of LTO review.	Outdated industry standards no longer represent optimal operating procedures and practices and do not reflect the latest information gained from research investigations and operating experience. The applicant for LTO license extension should be required to update its water chemistry control program as necessary to maintain compliance with current standards.	Verify that the applicant for LTO has maintained current water chemistry standards.
Program Consistency and Commitments		
The Ginna Water Chemistry Control Program (B2.1.37) claims consistency with GALL, Rev. 0, with no exceptions, enhancements, or commitments. The NMP-1 amended LRA Water Chemistry Control Program (B2.1.2) takes exception to GALL in that it utilizes a more recent version of the EPRI BWR water chemistry guidance than that given in GALL, Rev. 0 (EPRI TR-103515, Revs. 1 and 2 rather than TR-103515, Rev. 0). No enhancements to GALL are identified in the amended LRA. The NMP-1 exception impacts program elements 3 (Parameters Monitored/Inspected), 5 (Monitoring and Trending), and 6 (Acceptance Criteria). No commitments are identified.		
c.1: See item b.1 above.	See item b.1 above.	
1. Scope of Program		
The program includes components in the reactor coolant system, the engineered safety features, the auxiliary systems, and the steam and power conversion system. This program addresses the metallic components subject to aging management review that are exposed to a treated water environment controlled by the water chemistry program.		
1.1: No specific concerns for LTO.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2. Preventive Actions		
The program includes specifications for chemical species, impurities and additives, sampling and analysis frequencies, and corrective actions for control of reactor water chemistry. System water chemistry is controlled to minimize contaminant concentration and mitigate loss of material due to general, crevice, and pitting corrosion and cracking caused by SCC. For BWRs, maintaining high water purity reduces susceptibility to SCC, and chemical additive programs such as hydrogen water chemistry, or noble metal chemical application also may be used. For PWRs, additives are used for reactivity control and to control pH and inhibit corrosion.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
The concentrations of corrosive impurities listed in the EPRI water chemistry guidelines are monitored to mitigate loss of material, cracking, and reduction of heat transfer. Water quality also is maintained in accordance with the guidance. Chemical species and water quality are monitored by in-process methods or through sampling. The chemical integrity of the samples is maintained and verified to ensure that the method of sampling and storage will not cause a change in the concentration of the chemical species in the samples.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
This is a mitigation program and does not provide for detection of any aging effects of concern for the components within its scope. The monitoring methods and frequency of water chemistry sampling and testing is performed in accordance with the EPRI water chemistry guidelines and based on plant operating conditions. The main objective of this program is to mitigate loss of material due to corrosion and cracking due to SCC in components exposed to a treated water environment.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
Chemistry parameter data are recorded, evaluated, and trended in accordance with the EPRI water chemistry guidelines.		
5.1: See item a.1 above.	See item a.1 above.	
6. Acceptance Criteria		
Maximum levels for various chemical parameters are maintained within the system-specific limits as indicated by the limits specified in the corresponding EPRI water chemistry guidelines.		
6.1: No specific concerns for LTO.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7. Corrective Actions		
Any evidence of aging effects or unacceptable water chemistry results are evaluated, the cause identified, and the condition corrected. When measured water chemistry parameters are outside the specified range, corrective actions are taken to bring the parameter back within the acceptable range (or to change the operational mode of the plant) within the time period specified in the EPRI water chemistry guidelines. Whenever corrective actions are taken to address an abnormal chemistry condition, increased sampling or other appropriate actions may be used to verify the effectiveness of these actions. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Following corrective actions, additional samples are taken and analyzed to verify that the corrective actions were effective in returning the concentrations of contaminants, such as chlorides, fluorides, sulfates, dissolved oxygen, and hydrogen peroxide, to within the acceptable ranges. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: See item a.1 above.	See item a.1 above.	
9. Administrative Controls		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
The EPRI guideline documents have been developed based on plant experience and have been shown to be effective over time with their widespread use. The specific examples of operating experience are as follows: *BWR:* Intergranular stress corrosion cracking (IGSCC) has occurred in small- and large-diameter BWR piping made of austenitic stainless steels and nickel-base alloys. Significant cracking has occurred in recirculation, core spray, residual heat removal systems, and reactor water cleanup system piping welds. IGSCC has also occurred in a number of vessel internal components, including core shroud, access hole cover, top guide, and core spray spargers (Nuclear Regulatory Commission [NRC] Bulletin 80-13, NRC Information Notice [IN] 95-17, NRC Generic Letter [GL] 94-03, and NUREG-1544). No occurrence of SCC in pentaborate solution has ever been reported (NUREG/CR-6001).		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
PWR Primary System: The potential for SCC-type mechanisms might normally occur because of inadvertent introduction of contaminants into the primary coolant system, including contaminants introduced from the free surface of the spent fuel pool (which can be a natural collector of airborne contaminants) or the introduction of oxygen during plant cooldowns (NRC IN 84–18). Ingress of demineralizer resins into the primary system has caused IGSCC of Alloy 600 vessel head penetrations (NRC IN 96-11, NRC GL 97-01). Inadvertent introduction of sodium thiosulfate into the primary system has caused IGSCC of steam generator tubes. SCC has occurred in safety injection lines (NRC INs 97-19 and 84-18), charging pump casing cladding (NRC INs 80-38 and 94-63), instrument nozzles in safety injection tanks (NRC IN 91-05), and safety-related SS piping systems that contain oxygenated, stagnant, or essentially stagnant borated coolant (NRC IN 97-19). Steam generator tubes and plugs and Alloy 600 penetrations have experienced primary water stress corrosion cracking (NRC INs 89-33, 94-87, 97-88, 90-10, and 96-11; NRC Bulletin 89-01 and its two supplements). IGSCC-induced circumferential cracking has occurred in PWR pressurizer heater sleeves (NRC IN 2006-27). *PWR Secondary System:* Steam generator tubes have experienced outer diameter stress corrosion cracking (ODSCC), intergranular attack (IGA), wastage, and pitting (NRC IN 97-88, NRC GL 95-05). Carbon steel support plates in steam generators have experienced general corrosion. The steam generator shell has experienced pitting and stress corrosion cracking (NRC INs 82-37, 85-65, and 90-04). Extensive buildup of deposits at steam generator tube support holes can result in flow-induced vibrations and tube cracking (NRC IN 2007-37). Such operating experience has provided feedback to revisions of the EPRI water chemistry guideline documents.		
10.1: (NMP-1 plant visit) A review of water chemistry operating experience at NMP-1 during the recent audit revealed numerous problems in implementing their hydrogen water chemistry, noble metal chemical application, and zinc feedwater addition programs. These problems controlling levels, which have been compounded by numerous failures of the computer system that controls the hydrogen addition levels, have manifested themselves in the form of wide electrochemical potential (ECP) fluctuations and elevated Co-60 levels in the coolant.	Similar problems have occurred at other BWRs during the implementation of these mitigation steps, and their long-term effects on piping integrity in the recirculation system are not entirely known. This underscores the desirability of conducting a one-time inspection that samples the entire recirculation system prior to entering into LTO, as discussed under line item a.1 above. In addition, the applicant needs to demonstrate that they have achieved and maintained stable GALL-compliant water chemistry before entering into LTO.	Consider one-time inspection that samples the entire recirculation system; verify stable GALL-compliant water chemistry prior to entering into LTO.
10.2: (Ginna plant visit) Ginna (a PWR) has also reported water chemistry control problems. The problems generally involved levels of specific impurities exceeding EPRI guidelines, particularly during startup and transient	The applicant needs to demonstrate that they have achieved and maintained stable GALL-compliant water chemistry before entering into LTO.	See above

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
operating conditions.		
10.3: (Ginna plant visit) Ginna uprated power by 17% at the beginning of Cycle 33; during the subsequent cycle 34, iron transport was higher, as indicated by a review of primary and secondary chemistry. During cycle 34, approximately 89 lbs. of iron oxides were transported by the feedwater to the steam generators.	Only limited operating experience (a few operating cycles) is generally available with respect to the possible effects of power uprates on water chemistry control.	Review operating experience (OE) subsequent to extended power uprates (EPUs) to verify stable GALL-compliant water chemistry prior to entering into LTO.
10.4: See item a.1 above.	See item a.1 above.	See item a.1 above.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines*-2008 Revision, Electric Power Research Institute, Palo Alto, CA, October 2008.

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NRC Generic Letter 97-01, *Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations*, U.S. Nuclear Regulatory Commission, April 1, 1997.

NRC Information Notice 80-38, *Cracking in Charging Pump Casing Cladding*, U.S. Nuclear Regulatory Commission, October 31, 1980.

NRC Information Notice 82-37, *Cracking in the Upper Shell to Transition Cone Girth Weld of a Steam Generator at an Operating PWR*, U.S. Nuclear Regulatory Commission, September 16, 1982.

NRC Information Notice 84-18, *Stress Corrosion Cracking in Pressurized Water Reactor Systems*, U.S. Nuclear Regulatory Commission, March 7, 1984.

NRC Information Notice 85-65, *Crack Growth in Steam Generator Girth Welds*, U.S. Nuclear Regulatory Commission, July 31, 1985.

NRC Information Notice 89-33, *Potential Failure of Westinghouse Steam Generator Tube Mechanical Plugs*, U.S. Nuclear Regulatory Commission, March 23, 1989.

NRC Information Notice 90-04, *Cracking of the Upper Shell-to-Transition Cone Girth Welds in Steam Generators*, U.S. Nuclear Regulatory Commission, January 26, 1990.

NRC Information Notice 90-10, *Primary Water Stress Corrosion Cracking (PWSCC) of Inconel 600*, U.S. Nuclear Regulatory Commission, February 23, 1990.

NRC Information Notice 91-05, *Intergranular Stress Corrosion Cracking In Pressurized Water Reactor Safety Injection Accumulator Nozzles*, U.S. Nuclear Regulatory Commission, January 30, 1991.

NRC Information Notice 94-63, *Boric Acid Corrosion of Charging Pump Casing Caused by Cladding Cracks*, U.S. Nuclear Regulatory Commission, August 30, 1994.

NRC Information Notice 94-87, *Unanticipated Crack in a Particular Heat of Alloy 600 Used for Westinghouse Mechanical Plugs for Steam Generator Tubes*, U.S. Nuclear Regulatory Commission, December 22, 1994.

NRC Information Notice 95-17, *Reactor Vessel Top Guide and Core Plate Cracking*, U.S. Nuclear Regulatory Commission, March 10, 1995.

NRC Information Notice 96-11, *Ingress of Demineralizer Resins Increase Potential for Stress Corrosion Cracking of Control Rod Drive Mechanism Penetrations*, U.S. Nuclear Regulatory Commission, February 14, 1996.

NRC Information Notice 97-19, *Safety Injection System Weld Flaw at Sequoyah Nuclear Power Plant, Unit 2*, U.S. Nuclear Regulatory Commission, April 18, 1997.

NRC Information Notice 97-88, *Experiences during Recent Steam Generator Inspections*, U.S. Nuclear Regulatory Commission, December 16, 1997.

NRC Information Notice 2006-27, *Circumferential Cracking in the Stainless Steel Pressurizer Heater Sleeves of Pressurized Water Reactors*, December 11, 2006.

NRC Information Notice 2007-37, *Buildup of Deposits in Steam Generators*, November 23, 2007.

NUREG-1544, *Status Report: Intergranular Stress Corrosion Cracking of BWR Core Shrouds and Other Internal Components*, U.S. Nuclear Regulatory Commission, March 1, 1996.

NUREG/CR-6001, *Aging Assessment of BWR Standby Liquid Control Systems*, G. D. Buckley, R. D. Orton, A. B. Johnson Jr., and L. L. Larson, 1992.

A.3 XI.M3 Reactor Head Closure Stud Bolting

The verbatim text of GALL, Rev. 2, AMP XI.M3, Reactor Head Closure Stud Bolting, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program includes (a) inservice inspection (ISI) in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Subsection IWB (2004 edition,[2] no addenda), Table IWB 2500-1; and (b) preventive measures to mitigate cracking. The program also relies on recommendations to address reactor head stud bolting degradation as delineated in NUREG-1339 and Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.65.		
a.1: The program description for XI.M3 AMP in Rev. 2 of the GALL report does not include the objective of the AMP.	The program description in GALL, Rev. 2, does not state which aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the most important component of the program description and should be clearly described in this section.	Revise the program description to include the objective of this AMP.
a.2: There is a significant inconsistency in the inspection program recommended by the GALL AMP XI.M3 for the reactor head closure studs. Chapter 1 of Rev. 2 of the GALL Report states, "the following ASME Section XI editions and addenda are acceptable and should be treated as consistent with the GALL Report: (1) from the 1995 edition to the 2004 edition, as modified and limited in 10 CFR 50.55a, and (2) more recent editions, as evaluated for their adequacy for license renewal and discussed in the accompanying FRN for 10 CFR 50.55a rulemaking endorsing those specific editions." However, the inspection program in Section XI Table IWB-2500-1, Examination	For closure head bolting, since ISI is typically performed when the studs are removed, the ASME Section XI inspection requirements for plants that follow the 1995 to 2000 editions of the Code are more stringent than for the plants that follow the 2001 and later editions of the Code. The former require both volumetric and surface examinations, while the latter require only volumetric examination. It is not clear whether the applicants, with PWRs, who committed to inspection requirements of the 1995 to 2000 editions of the ASME Code, would continue to follow the	Revise the program description to include clarification for the difference between the 1995 to 2000 editions and the 2001 and later editions

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.
[2] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Category B-G-1 for closure head studs was changed in 2001 and later editions of ASME Code. The inspection requirements in the 1995 to 2000 editions of the Code included in Item B6.20, which specified volumetric examination of studs in place under tension, and Item B6.30, which specified surface and volumetric examination of studs when removed. The 2001 and later editions of the ASME Section XI Table IWB-2500-1, Examination Category B-G-1, include only Item B6.30, and require volumetric examination of the studs in place under tension, when the connection is disassembled, or when removed.	earlier editions of the Code or could switch to later editions of the Code and perform only volumetric examination of the studs when removed. The program description should include clear guidance regarding these differences in the Code inspection requirements. In addition, for BWRs, please see comment a.3 below regarding the differences between the ASME Code and BWRVIP-74-A guidelines. In addition, program elements 3 "Parameters Monitored/Inspected" and 4 "Detection and Aging Effects" should clarify these differences between the GALL requirements and BWRVIP-74-A programs.	of the ASME Code.
a.3: An inconsistency in the GALL AMP XI.M3 for closure head studs is that the inspection program recommended in the 2001 and later editions of the ASME Code is inconsistent with what is recommended in the BWRVIP-74-A document that was approved by the NRC. The BWRVIP-74-A program is consistent with the program recommended in the 1995 to 2000 edition of the Code.	Regardless of the version of the GALL AMP that was referenced in the LRA and approved by the NRC in its SER, all BWRs are committed to follow the BWRVIP-74-A guidance and perform both surface and volumetric examination when the studs are removed. Unless these plants receive NRC approval for a deviation from BWRVIP-74-A guidance or the BWRVIP guidance is revised, they would continue to follow the BWRVIP-74-A guidance through the period of extended operation. The program description should clarify that, for BWRs, the BWRVIP-74-A guidance is more stringent than that of GALL, Rev. 2, and requires both surface and volumetric examination when studs are removed, and that the applicants should continue to follow the BWRVIP-74-A guidance.	Revise the program description to include this clarification for BWRs.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes, as part of the program description, the guidance in NRC RG 1.65 R1, 2010 and NUREG-1339, 1990. However, the AMPs approved for both the Ginna and NMP-1 plants are the GALL, Rev. 0, version, which includes the guidance of RG 1.65, 1973, and the requirements of material tensile strength are based on PVP 1971, paper #11.		
b.1: Although program description of the GALL AMP refers to guidance of RG 1.65 and NUREG-1339, it does not	Nearly all applicants use a "boiler plate" statement that its AMP is consistent with the recommendations of these	Revise program

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
provide any details about which particular guidance is being recommended in the AMP.	documents, but do not provide any other details. It would be helpful for consistency in implementation if the specific guidance in these documents was clearly identified in the program description. For example, the preventive measures described in program element 2, "Preventive Actions," should be included in the program description. Additional preventive measures are described in RG 1.65 regarding protecting the studs and stud bolt holes in the vessel flange from corrosion and contamination during the venting and filling of the pressure vessel while the head is removed; those not described in the GALL, Rev. 2, AMP should also be included in the program description.	description to clearly identify significance of the basis and supporting documents.
Program Consistency and Commitments		
The AMP for both Ginna and NMP-1 plants is consistent with the GALL, Rev. 0, AMP XI.M3 Reactor Head Closure Studs, and there are no commitments in the SER for this program.		
c.1: The GALL, Rev. 0, AMP refers to 1995 edition (and 1996 addenda) of the ASME Code Section XI, Subsection IWB. Table IWB-2500-1 of the 1995 edition of the Code includes two options for inspecting closure studs. Item B6.20 recommends volumetric examination of closure studs in place under tension, and Item B6.30 recommends volumetric and surface examination of closure studs when removed. This Code requirement is consistent with the guidance in NRC RG 1.65, R0, and with the guidelines in BWRVIP-74-A, which was approved June 2003; therefore all BWRs must implement the BWRVIP-74-A guidance. See comments a.1 and a.2 for additional details.	The Rev. 1 or 2 AMPs of GALL refer to 2001 or 2004 editions of the ASME Code Section XI. Both these and later editions of the Code require only volumetric examination of the studs either in place or when removed. This guidance for inspection of the studs is consistent with the revised version of RG 1.65 R1, 2010. However, it is not clear whether the plants that committed to follow GALL, Rev. 0, AMP XI.M3 in their LRA continue to follow the Rev. 0 guidance even though they may be currently committed to later editions of the Code. In addition, after 2003, all BWRs were required to follow the guidelines in BWRVIP-74-A, which is consistent with the GALL, Rev. 0, AMP. Unless they ask NRC approval for a deviation from BWRVIP-74-A, they continue with the BWRVIP-74-A inspection guideline.	Revise or update the program description to include clear guidance regarding different versions of the GALL AMP.
c.2: (Ginna plant visit) LRA Appendix Section A, "Updated Final Safety Analysis Report (UFSAR) Supplement," does	However, the ISI described in UFSAR Section 18.2.1.2 includes only the inspection requirements for the reactor	Revise or update the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
not include a summary of this program. The licensee indicated that the program basis document for the ASME ISI, Subsections IWB, IWC and IWD Program includes the Reactor Head Closure Studs Program; therefore, no separate program basis document for the Reactor Head Closure Studs Program was prepared.	head closure stud assembly, and does not refer to NUREG-1339 and NRC RG 1.65, which address recommendations for preventive measures to manage SCC of reactor head closure studs. The program description should clarify that XI.M3 is a separate AMP and should not be included in some other AMP such as XI.M1 ASME Section XI, Inservice Inspection Subsections IWB, IWC, and IWD program.	program description to include this clarification.
c.3: (Ginna plant visit) Although the Ginna bolting integrity program is based on NUREG-1339, which recommends a maximum yield strength less than 150 ksi, its reactor head closure stud bolting program states that the closure studs are fabricated from SA-320 Gr. L43 (AISI 4340) low-alloy steel with minimum yield strength of 105 ksi, and thus are not susceptible to SCC.	It is not clear how many of the heats or product lots have yield strength greater than 150 ksi. The Ginna plant SER (NUREG-1786) identified this exception and stated that it is possible that the studs could have been heat treated to a yield strength of 150 ksi (1034 MPa) and could be susceptible to SCC. The SER further adds that since the reactor head closure studs program relies on ASME Section XI, Subsection IWB, to monitor for SCC, this aging effect will be managed by this program. However, for subsequent license renewal, additional guidance should be included for plants with closure studs that may be susceptible to SCC. See additional details in comments 2.1 below and b.1 above.	Revise program description to clearly identify significance of basis and supporting documents.
1. Scope of Program		
The program manages the aging effects of cracking due to stress corrosion cracking (SCC) or intergranular stress corrosion cracking (IGSCC) and loss of material due to wear or corrosion for reactor vessel closure stud bolting (studs, washers, bushings, nuts, and threads in flange) for both boiling water reactors (BWRs) and pressurized water reactors (PWRs).		
2. Preventive Actions		
Preventive measures include: (a) Avoiding the use of metal-plated stud bolting to prevent degradation due to corrosion or hydrogen embrittlement; (b) Using manganese phosphate or other acceptable surface treatments; (c) Using stable lubricants. Of particular note, use of molybdenum disulfide (MoS_2) as a lubricant has been shown to be a potential		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
contributor to SCC and should not be used (RG 1.65); and (d) Using bolting material for closure studs that has an actual measured yield strength less than 1,034 megapascals (MPa) (150 kilo-pounds per square inch) (NUREG-1339). Implementation of these mitigation measures can reduce potential for SCC or IGSCC, thus making this program effective.		
2.1: (Ginna & NMP-1 plant visits) The GALL XI.M3 R1 program includes preventive measures of RG 1.65 to mitigate cracking, and recommends that the maximum tensile strength of the studs/nuts be limited to 1,172 MPa (170 ksi). The XI.M3 R2 program provides a more conservative guidance and recommends using bolting materials for closure studs that have an actual measured yield strength less than 1,034 MPa (150 ksi). The Ginna LRA and SER state that the closure studs are fabricated from SA-320 Gr. L43 (AISI 4340) low-alloy steel and thus are not susceptible to SCC (specified minimum yield strength of 105 ksi). Although the Ginna bolting integrity program is based on NUREG-1339, which recommends a maximum yield strength less than 150 ksi, it is not clear how many of the heats or product lots had a yield strength greater than 150 ksi. In addition, the Nine Mile Point Unit 1 LRA was reviewed based on the guidance of GALL R1. It was verified that the ultimate tensile strength of the stud bolting material is less than 170 ksi. It is not clear how many of the studs have a yield strength that exceeds the GALL R2 recommendation of 150 ksi.	Some heats or product lots of the closure stud bolting material are likely to exceed the yield strength (YS) limit although they may or may not meet the maximum UTS limit of 170 ksi, and would be considered susceptible to SCC. It is clear that such materials would be more susceptible to SCC. It is also known that in several plants some of the heats or bar stock within a heat do not meet this guidance. Diablo Canyon could not identify which studs were from the suspect bar stock, so all studs must be treated as susceptible to SCC. The AMP for subsequent license renewal needs to provide guidance on how to address potential cracking of high-strength steels that are susceptible to SCC. An assessment may be in order to determine if there is a need to enhance the inspection program including an increase in the inspection frequency? For such situations, it may be recommended that a leakage event that could promote SSC of the reactor head closure bolting be identified as an “operating experience precursor” that addresses a need for further aging management activity to ensure that the current conditions of the environment and components are acceptable with no significant adverse effect postulated on the aging degradation of the reactor head bolting components. The following two AMP	Revise or update element 2 of the AMP to include clear guidance for plants that have SCC susceptible materials (i.e., YS exceeds 150 ksi).

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	activities may be emphasized: (i) perform a flaw tolerance evaluation using fatigue crack growth (or both fatigue and SCC crack growth) to demonstrate the adequacy of the ASME Code Section XI 10-year inspection interval, and (ii) provide a safety assessment that evaluates the consequences of aging degradation.	
2.2: Although program description of the GALL AMP refers to guidance from RG 1.65 and NUREG-1339, it does not provide any details on particular guidance is being recommended in the AMP. If the specific guidance in these documents were clearly identified, then the program implementation would be unambiguous and consistent	It would be prudent and helpful in efficient and effective program implementation if the specific guidance in these documents is identified clearly. The preventive actions program element should include RG 1.65 guidance regarding protecting the studs and stud bolt holes in the vessel flange from corrosion and contamination during the venting and filling of the pressure vessel while the vessel head is removed.	Revise to include specific aging management guidance on protecting the studs and stud bolt holes during outage.
3. Parameters Monitored/Inspected		
The ASME Section XI ISI program detects and sizes cracks, detects loss of material, and detects coolant leakage by following the examination and inspection requirements specified in Table IWB-2500-1.		
3.1: ISI in accordance with ASME Section XI (2001 or later editions) Table IWB-2500-1, Examination Category B-G-1, pressure retaining bolting >2 in. in diameter consists of: VT-1 of RV closure nuts; volumetric examination of closure head studs in place under tension, or when the connection is disassembled, or when the bolting is removed; volumetric exam of threads in the base material of the reactor flange; VT-1 of the closure head washers and bushings; volumetric exam of the flange ligaments; and VT-2 exam in conjunction with system leakage test.	The requirements for Examination Category B-G-1 changed between the 1998 and 2001 editions of the ASME Section XI. The 1998 and earlier versions of the Code required both surface and volumetric examination when the studs were removed. This inspection guidance was also recommended in NRC RG 1.65, Rev. 0, and is recommended in the BWRVIP-74-A document. See additional details in comments a.1 and a.2 above.	Revise element 3 to include clarification of the difference between GALL and BWRVIP inspection guidance.
4. Detection of Aging Effects		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The extent and schedule of the inspection and test techniques prescribed by the program are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component. Inspection can reveal cracking, loss of material due to corrosion or wear, and leakage of coolant. The program uses visual, surface, and volumetric examinations in accordance with the general requirements of Subsection IWA-2000. Surface examination uses magnetic particle or liquid penetrant examinations to indicate the presence of surface discontinuities and flaws. Volumetric examination uses radiographic or ultrasonic examinations to indicate the presence of discontinuities or flaws throughout the volume of material. Visual VT-2 examination detects evidence of leakage from pressure-retaining components, as required during the system pressure test. Components are examined and tested in accordance with ASME Code, Section XI, Table IWB-2500-1, Examination Category B-G-1, for pressure-retaining bolting greater than 2 inches in diameter. Examination Category B-P for all pressure-retaining components specifies visual VT-2 examination of all pressure-retaining boundary components during the system leakage test. Table IWB-2500-1 specifies the extent and frequency of the inspection and examination methods, and IWB-2400 specifies the schedule of the inspection.		
4.1: The GALL R2 AMP XI.M3 and the latest revision of RG 1.65 both recommend volumetric examination of studs in place or removed, which is the requirement of ASME Code Section XI, Subsection IWB (2001 or later editions), Table IWB 2500-1. However, for BWRs, the applicants are required to comply with BWRVIP-74-A guidance, which requires volumetric examination for studs in place under tension or volumetric and surface examination when studs are removed. This requirement is being met by BWRs throughout the current 40-year period. It is also consistent with the GALL R0 AMP or Table IWB-2500-1 (1989 edition). In some cases (e.g., Columbia LRA), the applicant has committed to following ASME Code 2004 edition inspection requirements for the extended period but stated in Appendix C of their LRA that they do not have any conflict with the applicant action items listed in NRC SER for BWRVIP-74-A (i.e., inspection of studs is in accordance with the BWRVIP-74-A guidance).	The LRAs for other BWRs, such as Dresden 2&3, Monticello, Nine Mile Point 1, or Cooper, may be reviewed to determine if they have also proposed two different inspection programs for the period of extended operation. To follow the ASME Section XI requirements during the PEO, the applicant would have to justify the deviation from the BWRVIP guidance, or otherwise continue following the BWRVIP-74-A guidance. The GALL AMP XI.M3 should include some clarification regarding the difference between the inspection requirements in ASME Section XI, Table IWB 2500-1, and the BWRVIP-74-A report. See additional details in comments a.1 and a.2 above.	Revise element 4 of the AMP to include clarification lf the difference between ASME Code and BWRVIP inspection guidance.
5. Monitoring and Trending		
The Inspection schedule of IWB-2400 and the extent and frequency of IWB-2500-1 provide timely detection of cracks, loss of material, and		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
leakage.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Any indication or relevant condition of degradation in closure stud bolting is evaluated in accordance with IWB-3100 by comparing ISI results with the acceptance standards of IWB-3400 and IWB-3500.		
6.1: No further review item was identified.		
7. Corrective Actions		
Repair and replacement are performed in accordance with the requirements of IWA-4000 and the material and inspection guidance of RG 1.65. The maximum yield strength of replacement material should be limited as recommended in NUREG-1339. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
SCC has occurred in BWR pressure vessel head studs (Stoller, 1991). The aging management program has provisions regarding inspection techniques and evaluation, material specifications, corrosion prevention, and other aspects of reactor pressure vessel head stud cracking. Implementation of the program provides reasonable assurance that the effects of cracking due to SCC or IGSCC and loss of material due to wear are adequately managed so that the intended functions of the reactor head closure studs and bolts are maintained consistent with the current licensing basis for the period of extended operation. Degradation of threaded bolting and fasteners in closures		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
for the reactor coolant pressure boundary has occurred from boric acid corrosion, SCC, and fatigue loading (NRC Inspection and Enforcement Bulletin 82-02, NRC Generic Letter 91-17).		
10.1: (NMP-1 plant visit) For periodic assessment and improvement of program effectiveness based on the review of operating experience, the licensee generates and reviews program health reports for the ASME Section XI, ISI Program, which includes inspections of the reactor head closure studs.	The licensee also indicated that these health reports have not identified a significant concern related to this program.	Licensee performs self assessment.
10.2: There are 14 applicant action items (AAIs) associated with the NRC SER for BWRVIP-74-A. AAI #8 states that the license renewal (LR) applicant should verify that the number of cycles assumed in the original fatigue design is conservative to assure that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, an LR applicant must address environmental fatigue for the components listed in the BWRVIP-74-A report for the license period. These components or locations include closure studs, nozzles, penetrations, safe-ends, vessel support skirt, and vessel external attachments.	This comment is not directly related to this AMP but involves the time-limited aging analysis (TLAA) associated with reactor head closure studs. Typically, environmental effects are not included in the fatigue cumulative usage factor (CUF) TLAA for the closure studs. However, since the major focus of this AMP is to manage the effects of SCC/IGSCC in leaking reactor coolant environment, the CUF analyses should also include the effect of leaking coolant environment. This is also recommended by AAI #8 of BWRVIP-74-A. It would be helpful to check whether the fatigue CUF analysis for the closure studs is performed in accordance with the guidance of this AAI.	Recommend that the fatigue CUF TLAAs for reactor head closure studs include environmental effects.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

NRC Regulatory Guide 1.65, *Material and Inspection for Reactor Vessel Closure Studs*, Revision 1, U.S. Nuclear Regulatory Commission, April 2010.

NRC Inspection and Enforcement Bulletin 82-02, *Degradation of Threaded Fasteners in the Reactor Coolant Pressure Boundary of PWR Plants*, June 2, 1982.

NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, June 1990.

NRC Generic Letter 91-17, *Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants,* October 17, 1991.

Stoller, S. M., *Reactor Head Closure Stud Cracking, Material Toughness Outside FSAR – SCC in Thread Roots*, Nuclear Power Experience, BWR-2, Ill, 58, p. 30, 1991.

A.4 XI.M4 BWR Vessel ID Attachment Welds

The verbatim text of GALL, Rev. 2, AMP XI.M4, BWR Vessel ID Attachment Welds, is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item that is based on the visit to the NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[2]
Program Description		
The program includes inspection and flaw evaluation in accordance with the guidelines of a staff-approved boiling water reactor vessel and internals project (BWRVIP-48-A) to provide reasonable assurance of the long-term integrity and safe operation of boiling water reactor (BWR) vessel inside diameter (ID) attachment welds. The guidelines of BWRVIP-48-A include inspection recommendations and evaluation methodologies for the attachment welds between the vessel wall and vessel ID brackets that attach safety-related components to the vessel (e.g., jet pump riser braces and core spray piping brackets). In some cases, the attachment is a simple weld; in others, it includes a weld build-up pad on the vessel. The BWRVIP-48-A guidelines include information on the geometry of the vessel ID attachments; evaluate susceptible locations and safety consequence of failure; provide recommendations regarding the method, extent, and frequency of inspection; and discuss acceptable methods for evaluating the structural integrity significance of flaws detected during these examinations.		
a.1: The program description for XI.M4 AMP in Rev. 2 of the GALL report does not include the objective of the program. The program description does not state which aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the most important component of the program description and should be clearly described in this section.	Although the purpose of the AMP is described in Program Element 1, "Scope of Program," the program description should include the purpose of the AMP and state clearly that this program is focused on managing the effects of cracking due to SCC, including IGSCC in BWR vessel ID attachment welds.	Revise the program description to include the objective.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP for reactor vessel ID attachment welds is essentially based on (a) the inspection and flaw evaluation guidelines in BWRVIP-48-A *(*EPRI 1016569), and (b) reactor coolant water chemistry control in accordance with BWRVIP-190 (EPRI 1016579).		
b.1: (NMP-1 plant visit) The program basis document is based on BWRVIP-48-A and has Applicant Action Items (AAIs) associated with its NRC SER. The applicants are	The guidance of this BWRVIP document must be implemented by all BWR licensees. Site procedures require a technical justification to be documented, and the	Include guidance for applicant to

[2] Proposed NRC action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[2]
required to address these AAIs in Appendix C of its LRA.	NRC to be notified, for any deviation from the guidelines. To ensure compliance, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP report referenced in the AMP.	address all AAIs related to the BWRVIP report referenced in the AMP.
Program Consistency and Commitments		
The NMP-1 program is consistent with GALL AMP XI.M4, Rev. 0.		
c.1: (NMP-1 plant visit) Consistent with the GALL, Rev. 0, AMP, the NMP-1 program includes (a) inspection and flaw evaluation in accordance with the guidelines in staff-approved BWRVIP-48 and (b) monitoring and control of reactor coolant water chemistry in accordance with the guidelines in BWRVIP-29 (TR-103515) to ensure the long-term integrity and safe operation of BWR vessel ID attachment welds.	The main differences between the AMPs in GALL, Rev. 0, and GALL, Rev. 2, are that the latter has <u>an augmented ISI program</u> that uses the inspection and flaw evaluation criteria in BWRVIP-48-A to detect cracking and monitor the effects of cracking on the intended function of the components, and the water chemistry control is in accordance with the latest version of the industry document, BWRVIP-130. The enhanced visual VT-1 examination suggested in GALL, Rev. 0, is capable of achieving <u>a 1-mil wire resolution</u>, whereas in GALL, Rev. 2, it is capable of achieving <u>a ½-mil (0.0005-inch) wire resolution</u>. Also see Comment 4.1.	Update the program description and Element 4 to include some clarification for licensees who implemented the GALL, Rev. 0, AMP.
1. Scope of Program		
The program is focused on managing the effects of cracking due to stress corrosion cracking (SCC), including intergranular stress corrosion cracking (IGSCC). The program is an augmented inservice inspection program that uses the inspection and flaw evaluation criteria in BWRVIP-48-A to detect cracking and monitor the effects of cracking on the intended function of the components. The program provides for repair and/or replacement, as needed, to maintain the ability to perform the intended function. The program is applicable to structural welds for BWR reactor vessel internal integral attachments.		
1.1: The scope of program states that this program is applicable to structural welds for BWR reactor vessel internal integral attachments. However, it does not identify that the material of these welds is either stainless steel or	This information on the type of material used for the component construction and its associated weldment, including its composition should be included in the scope of program. Such detailed information is necessary to assess the efficacy of the mitigation actions described next in	Revise the scope of program to include information

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[2]
nickel alloy (typically Alloy 182 or 82).	preventive actions (e.g., hydrogen water chemistry (HWC) may not necessarily decrease the susceptibility to SCC or IGSCC of some Ni alloy welds). See Comment 2.1.	on weld material.
2. Preventive Actions		
The BWR Vessel ID Attachment Welds Program is a condition monitoring program and has no preventive actions. Maintaining high water purity reduces the susceptibility to SCC or IGSCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation, and technical basis of water chemistry are presented in GALL AMP XI.M2, "Water Chemistry."		
2.1: This program element states, "maintaining high water purity reduces susceptibility to SCC or IGSCC." However, this may not be true for some Ni-alloy welds.	Decreasing the corrosion potential of the coolant environment may not be beneficial for sensitized Ni alloy welds, particularly under crevice conditions. Therefore, this program element should be revised to include a clarification on the effect of HWC on the SCC susceptibility of Ni-alloy welds. In addition, some other mitigation measures, such as using more resistant weld metal (e.g., Alloy 82 instead of Alloy 182) or protective coatings, may be included in the program.	Revise Element 2 to include clarification on the SCC susceptibility of Ni alloys in HWC and mitigation measures.
3. Parameters Monitored/Inspected		
The program monitors for cracks induced by SCC and IGSCC on the intended function of BWR vessel ID attachment welds. The program looks for surface discontinuities that may indicate the presence of a crack in the component in accordance with the guidelines of approved BWRVIP-48-A and the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Table IWB 2500-1 (2004 edition)[3].		
3.1: (NMP-1 plant visit) The GALL, Rev. 0, AMP includes the following relief: An applicant may use the guidelines in BWRVIP-62 for inspection relief for vessel internal components with HWC.	The guidelines in BWRVIP-62 for inspection relief have been deleted from GALL, Rev 2. Regulatory decisions on reliefs are made on a case-by-case basis. Licensees can request a relief under 10 CFR 50.55a(a)(3) for the use of HWC, and such a relief is approved only for a 10-year	Revise Element 3 to include clarification for the

[3] Refer to GALL Report, Chapter I, for applicability of other editions of the ASME Code Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[2]
However, the applicant stated that the BWRVIP-62 guidelines are not being applied to NMP-1. Although NMP-1 utilizes HWC, it is conservatively not credited for inspection relief at either unit.	interval. While operating under HWC, since inspection relief under 10 CFR 50.55a(a)(3) in accordance with the guidelines in BWRVIP-62 is approved on a case-by-case basis, and only for 10 years, either BWRVIP-62 should be deleted from the reference section, or a better option would be add the above underlined information in this program element.	difference between GALL and BWRVIP inspection guidance.
4. Detection of Aging Effects		
The extent and schedule of the inspection and test techniques prescribed by BWRVIP-48-A guidelines are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function. Inspection can reveal cracking. Vessel ID attachment welds are inspected in accordance with the requirements of ASME Section XI, Subsection IWB, Examination Category B-N-2. The ASME Code, Section XI inspection specifies visual VT-1 examination to detect discontinuities and imperfections on the surfaces of components and visual VT-3 examination to determine the general mechanical and structural condition of the component supports. The inspection and evaluation guidelines of BWRVIP-48-A recommend more stringent inspections for certain attachments. The guidelines recommend enhanced visual VT-1 examination of all safety-related attachments and those non-safety-related attachments identified as being susceptible to IGSCC. Visual VT-1 examination is capable of achieving 1/32-inch resolution; the enhanced visual VT-1 examination method is capable of achieving a 1/2 mil (0.0005 inch) wire resolution. The nondestructive examination (NDE) techniques appropriate for inspection of BWR vessel internals, including the uncertainties inherent in delivering and executing NDE techniques in a BWR, are included in BWRVIP-03.		
4.1: (NMP-1 plant visit) The extent and schedule of the inspection and test techniques prescribed by BWRVIP-48 guidelines in the GALL, Rev. 0, version are the same as in the Rev. 2 version, except that GALL, Rev. 0, states, "the enhanced visual VT-1 examination method is capable of achieving a 1-mil wire resolution."	GALL, Rev. 2, states that "the enhanced visual VT-1 examination method is capable of achieving a ½-mil (0.0005-inch) wire resolution." However, it is not clear whether NMP have updated their AMP to have a higher resolution. For licensees who may have implemented the GALL, Rev. 0, AMP, it may be helpful to include clarification that for LTO license renewal, all applicants must implement the GALL, Rev. 2, AMP.	Revise Element 4 to include this clarification.
5. Monitoring and Trending		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[2]
Inspections scheduled in accordance with ASME Code, Section XI, IWB-2400 and approved BWRVIP-48-A guidelines provide timely detection of cracks. If flaws are detected, the scope of examination is expanded. Any indication detected is evaluated in accordance with ASME Code, Section XI or the staff-approved BWRVIP-48-A guidelines. Applicable and approved BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A documents provide guidelines for evaluation of crack growth in stainless steels, nickel alloys, and low-alloy steels, respectively.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Acceptance criteria are given in BWRVIP-48-A and ASME Code, Section XI.		
6.1: No further review item was identified.		
7. Corrective Actions		
Repair and replacement procedures are equivalent to those requirements in ASME Code, Section XI. Corrective action is performed in accordance with ASME Code, Section XI, IWA-4000. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the corrective action guidelines in BWRVIP-48-A provides an acceptable level of quality in accordance with 10 CFR Part 50, Appendix B corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-48-A provides an acceptable level of quality in accordance with the 10 CFR Part 50, Appendix B confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Cracking due to SCC, including IGSCC, has occurred in BWR components. The program guidelines are based on an evaluation of		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[2]
available information, including BWR inspection data and information on the elements that cause IGSCC, to determine which attachment welds may be susceptible to cracking. Implementation of this program provides reasonable assurance that cracking will be adequately managed and that the intended functions of the vessel ID attachments will be maintained consistent with the current licensing basis for the period of extended operation.		
The SER states that no industry OE with vessel ID attachment weld flaws has emerged since the release of BWRVIP-48. However, during EVT-1 of the steam dryer support brackets during the spring 2011 refueling outage (N1R21), relevant indications were detected in 3 of the 4 brackets. Indications are in the heat-affected zone (HAZ) and run parallel to the weld (i.e., no threat to propagate into and through the weld towards the vessel). The cause of indications is IGSCC, possibly due to residual stresses in the weld-sensitized bracket and applied dryer deadweight loads. The bracket is fabricated of high-Carbon A240 Type 304 SS and located in an aggressive environment above the area typically not protected by HWC. Visual inspection did not show signs of significant fretting indicative of flow induced vibrations (FIV) causing high-cycle fatigue. A flaw evaluation was conducted for an evaluation interval of one operating cycle to demonstrate that the structural margins contained in ASME B&PV Code Section XI are maintained throughout the evaluation interval, including consideration of flaw growth and continuing structural adequacy ((SI 1100539.401, July 2011). The follow-up corrective actions included revision of the flaw evaluation procedure to incorporate clear acceptance criteria for re-inspection and to demonstrate that the ASME Code structural margins are maintained during the evaluation interval.	The licensee plans the following actions: (1) Revise the flaw evaluation procedure to incorporate clear acceptance criteria for re-inspection and to demonstrate the margin between N1R21 as found indication data and the allowable criteria. (2) Confirm that existing flaw evaluations with ultrasonic testing (UT) and use depth and length uncertainties that are conservative. (3) Recommend re-inspect in N1R22 and a decision to develop contingency/pre-emptive repairs for N1R23 be made based on an evaluation of the N1R22 exam data. If no changes in cracking are evident, then successive EVT-1 exams will be performed in subsequent outages, and if significant change in cracking is apparent then a repair will be developed for implementation in N1R23. Such an acceptance criteria/corrective action may be considered for subsequent license renewal. The use of plant-specific OE for updating and implementing the program is considered a good practice or strength of the AMP.	Revise Program Element 10 to include such a recommendation.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

BWRVIP-03 (EPRI 105696 R1, March 30, 1999), *BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation for BWRVIP-03, July 15, 1999.

BWRVIP-14-A *(*EPRI 1016569), *Evaluation of Crack Growth in BWR Stainless Steel RPV Internals*, September 2008*.*

BWRVIP-48-A (EPRI 1009948), *BWR Vessel and Internals Project, Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines*, November 2004*.*

BWRVIP-59-A (EPRI 1014874), *Evaluation of Crack Growth in BWR Nickel-Base Austenitic Alloys in RPV Internals*, May 2007.

BWRVIP-60-A (EPRI 1008871), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Low Alloy Steel RPV Internals*, June 2003.

BWRVIP-62 (EPRI 108705), *BWR Vessel and Internals Project, Technical Basis for Inspection Relief for BWR Internal Components with Hydrogen Injection*, March 7, 2000.

BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines—2008 Revision*, October 2008.

Additional References (following audits)

NER-1M-078 "*Vessel ID Attachment Weld Inspection and Evaluation,*" Rev. 3, 2011.

SI 1100539.401, *Nine Mile Point Unit 1, Steam Dryer Support Bracket Flaw Evaluation*, July 2011, 62 pp, (ML 11207A435).

A.5 XI.M5 BWR Feedwater Nozzle

The verbatim text of GALL, Rev. 2, AMP XI.M5, BWR Feedwater Nozzle, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program includes enhanced inservice inspection (ISI) in accordance with (a) the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Subsection IWB, Table IWB 2500-1 (2004 edition[2]); (b) the recommendation of General Electric (GE) NE-523-A71-0594, Rev. 1, *Alternate BWR Feedwater Nozzle Inspection Requirements*; and (c) NUREG-0619 recommendations for system modifications to mitigate cracking. The program specifies periodic ultrasonic inspection of critical regions of the boiling water reactor (BWR) feedwater nozzle. Systems modifications to mitigate cracking may have been made, such as removal of stainless steel cladding and installation of improved spargers. Mitigation also is accomplished by changes to plant-operating procedures, such as improved feedwater control to decrease the magnitude and frequency of temperature fluctuations. These modifications are design and operating changes and were instituted for many BWRs during their initial 40-year operating period.		
a.1: (NMP-1 plant visit) The GALL AMP refers to two management activities. However, although it states that the ISI is in accordance with alternative inspection guidelines in NE-523-A71-0594 and mitigation is according to the activities documented in NUREG-0619, it would be prudent to clarify that ultrasonic testing (UT) and liquid penetration test (PT) inspections required by NUREG-0619 have been superseded by the guidance of NE-523-A71-0594 and inspections are now performed in accordance with ASME Section XI, Appendix VIII.	The program description may be revised to clarify that the UT and PT inspections required by NUREG-0619 have been superseded by the alternative inspection guidance in NE-523-A71-0594. Also, to be current and consistent with the guidance in the GALL Report, it would be prudent to update/revise NUREG-0619.	Revise program description of the AMP to include such clarification.
a.2: The program description for XI.M5 AMP in Rev. 2 of the GALL report does not include the objective of the program (i.e., cracking due to cyclic loading).	The program description in GALL, Rev. 2, does not state which aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the	Revise program description to

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.
[2] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	most important component of the program description and should be clearly described in this section.	include the objective.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP is essentially based on (a) enhanced ISI in accordance with the requirements of ASME Section XI, Subsection IWB, and the recommendations of GE report NE-523-A71-0594; and (b) mitigation measures documented in NUREG-0619.		
b.1: The alternative BWR feedwater nozzle inspection requires a demonstration that the UT method to be used is capable of detecting and sizing flaws with depths of 0.25 inch and greater, which meets the objectives of ASME Section XI, Appendix VIII. This assurance eliminates the need for the liquid penetrant test (PT) examination that was originally required in NUREG-0619 due to lack of confidence in the UT techniques. Furthermore, the inspection frequencies are based on the examination results and type of UT examination, sparger type, and the results of plant-specific fracture mechanics assessment.	It would be helpful for consistency in implementation of the AMP if the specific guidance in these two documents were clearly identified in the program description. For example, the inspection frequencies may be based on the results of a plant-specific fracture mechanics assessment, to demonstrate that small flaws will not grow to unacceptable sizes within the operating period for the BWR feedwater nozzles.	Revise program description to clearly identify the significance of the basis and supporting documents.
Program Consistency and Commitments		
The AMP for NMP-1 makes one exception to the GALL, Rev. 0, AMP XI.M5 BWR Feedwater Nozzle program; the NMP-1 program, as approved by the NRC staff, is based on the 1989 edition of the ASME Code. The NRC SERs dated Oct. 5, 2000, and March 3, 2000, found this acceptable.		
c.1: (NMP-1 plant visit) A significant deficiency in the inspection program proposed in the GALL AMP XI.M5 is the lack of guidance regarding the use of earlier editions of the ASME Section XI Code. Chapter 1 of Rev. 2 of the GALL report states, “the following ASME Section XI editions and addenda are acceptable and should be treated as consistent with the GALL Report: (1) from the 1995 edition to the 2004 edition, as modified and limited in 10 CFR 50.55a, and (2) more recent editions, as evaluated for their adequacy for license renewal and discussed in the accompanying FRN for 10 CFR 50.55a rulemaking endorsing those specific editions.” However, the NMP-1	Although the exception regarding 1989 edition of the Code is not significant, the program description should be updated to include some guidance for plants that committed to the inspection requirements of editions of the ASME Code before 1995, at the time of LRA approval.	Revise program description to include clear guidance regarding different editions of the ASME Code.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
AMP B2.1.5 for BWR feedwater nozzles consists of augmented examinations through the ISI Program, which is based on the 1989 edition of the ASME Section XI Code.		
1. Scope of Program		
The program includes enhanced ISI to monitor the effects of cracking due to cyclic loading and its impact on the intended function of BWR feedwater nozzles.		
1.1: No further review item was identified.		
2. Preventive Actions		
This program is a condition monitoring program and has no preventive actions.		
2.1: (NMP-1 plant visit) The description in the GALL Rev. 2 AMP is misleading. As described in the program description above, measures to mitigate cracking includes systems modification such as removal of stainless steel cladding and installation of improved spargers, and changes to plant-operating procedures, such as improved feedwater control to decrease the magnitude and frequency of temperature fluctuations.	This AMP includes several aging management activities (AMAs), including mitigation of cracking according to the recommendations of NUREG-0619. The description should be revised to include mitigation actions.	Revise or update element 2 of the AMP to include mitigation actions.
3. Parameters Monitored/Inspected		
The aging management program (AMP) monitors for cracking due to cyclic loading and its impact on the intended function of the BWR feedwater nozzle by detection and sizing of cracks by ISI in accordance with ASME Code, Section XI, Subsection IWB; the recommendation of GE NE-523-A71-0594, Rev. 1; and NUREG-0619 recommendations.		
3.1: If the recommendations of NUREG-0619 are only related to mitigation activities, any reference to recommendation in NUREG-0619 in this program element may cause confusion.	If the NUREG-0619 recommendations are not invoked for monitoring or inspection to detect cracking, to avoid confusion, it would be helpful to remove any reference to NUREG-0619 in this program element.	Revise element 3 to delete reference to NUREG-0619.
4. Detection of Aging Effects		
The extent and schedule of the inspection prescribed by the program are designed to ensure that aging effects are discovered and		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
repaired before the loss of intended function of the component. Inspection can reveal cracking. GE NE-523-A71-0594, Rev. 1 specifies ultrasonic testing (UT) of specific regions of the blend radius and bore. The UT examination techniques and personnel qualifications are in accordance with the guidelines of GE NE-523-A71-0594, Rev. 1. Based on the inspection method and techniques and plant-specific fracture mechanics assessments, the inspection schedule is in accordance with Table 6-1 of GE NE-523-A71-0594, Rev. 1. Leakage monitoring may be used to modify the inspection interval.		
4.1: As mentioned above in comment b.1, the inspection frequencies are based on the examination results and type of UT examination, sparger type, and the results of plant-specific fracture mechanics assessments. In addition, leakage monitoring may be used to modify the inspection interval.	As part of the license renewal, these licensing bases fracture mechanics assessments may need to be updated to be consistent with the recent applicable Codes and Standards, in particular the most recent mathematical relationships for crack growth rates, including the effects of reactor coolant environment. In addition, these analyses need to be updated to include the effects of any plant modification such as extended power uprate EPU, which can change the heat balance of the primary system (temperature, pressure, flow, and steam quality), and thus could potentially alter the original assumptions used in the derivation and application of mathematical relations and applications for crack growth predictions	Revise element 4 of the AMP to include such guidance.
5. Monitoring and Trending		
Inspections scheduled in accordance with GE NE-523-A71-0594, Rev. 1 provide timely detection of cracks.		
5.1: The detection of aging effects program element states that based on the inspection method and techniques and plant-specific fracture mechanics assessments, the inspection schedule is in accordance with Table 6-1 of GE NE-523-A71-0594, Rev. 1. In addition, leakage monitoring may be used to modify the inspection interval.	As mentioned above in comment 4.1, the fracture mechanics assessments need to be updated to include the effects of any plant modification such as EPU.	Revise element 5 of the AMP to include such guidance.
6. Acceptance Criteria		
Any cracking is evaluated in accordance with ASME Code, Section XI, IWB-3100 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3400 and IWB-3500.		
6.1: There are 14 AAIs associated with the NRC SER for BWRVIP-74-A. AAI #8 states that the LR applicant should	As mentioned above in comment b.1, the inspection frequencies are based on the examination results and type	Revise program to

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
verify that the number of cycles assumed in the original fatigue design is conservative to ensure that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, an LR applicant must address environmental fatigue for the components listed in the BWRVIP-74-A report for the license period. These components or locations are closure studs, nozzles, penetrations, safe-ends, vessel support skirt, and vessel external attachments.	of UT examination, sparger type, and the results of plant-specific fracture mechanics assessment. As part of the license renewal, these licensing basis fracture mechanics assessments need to be updated to be consistent with the recent Codes and Standards. In addition, to satisfy the recommendations of BWRVIP-74-A, an LR applicant must update the fatigue usage TLAAs, including environmental effects, for the components listed in the BWRVIP-74-A report (i.e., nozzles and safe ends).	ensure that fatigue crack growth and CUF analyses, including environmental effects, are updated.
7. Corrective Actions		
Repair and replacement are in conformance with ASME Code, Section XI, Subsection IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Cracking has occurred in several BWR plants (NUREG-0619, U.S. Nuclear Regulatory Commission [NRC] Generic Letter 81-11). This AMP has been implemented for nearly 30 years and has been found to be effective in managing the effects of cracking on the intended function of feedwater nozzles.		
10.1: No further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

GE-NE-523-A71-0594, Rev. 1, *Alternate BWR Feedwater Nozzle Inspection Requirements*, BWR Owner's Group, August 1999.

NRC Generic Letter 81-11, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking (NUREG-0619),* U.S. Nuclear Regulatory Commission, February 29, 1981.

NUREG-0619, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking*, U.S. Nuclear Regulatory Commission, November 1980.

A.6 XI.M6 BWR Control Rod Drive Return Line Nozzle

The verbatim text of GALL, Rev. 2, AMP XI.M6, BWR Control Rod Drive Return Line Nozzle, is included in the following worksheet; all blue text is directly transcribed. The information source for each line item is based on visit to NMP-1 plant and is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program is a condition monitoring program for boiling water reactor (BWR) control rod drive return line (CRDRL) nozzles that is based on the staff's recommended position in NUREG-0619 for thermal fatigue. This program is also intended to address stress corrosion cracking (SCC) discussed in NRC IN 2004-08. The augmented inspections performed in accordance with the recommendations in NUREG-0619 supplement those in-service inspections that are required for these nozzles in accordance with the American Society of Mechanical Engineers (ASME) Code, Section XI, Table IWB-2500-1, as mandated through reference in 10 CFR 50.55a. Thus, this program includes (a) mandatory in-service inspection (ISI) in accordance with the ASME Code, Section XI, Table IWB 2500-1 (2004 edition[2]), and (b) augmented ISI examinations in accordance with applicant's commitments to U.S. Nuclear Regulatory Commission (NRC) Generic Letter (GL) 80-095 to implement the recommendations in NUREG-0619.		
a.1: The program description for XI.M6 AMP in Rev. 2 of the GALL report does not clearly state the objective of the program (i.e., cracking due to cyclic loading, primarily thermal fatigue). The program manages crack initiation and growth in the CRDRL nozzle.	The program description does not describe clearly which aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the most important component of the program description and should be clearly included in this section.	Revise program description to include the objective.
a.2: (NMP-1 plant visit) The GALL AMP refers to two management activities. It states that augmented inspections are in accordance with the recommendations of NUREG-0619 as required by the ASME Section XI, Table IWB-2500-1, and as mandated through reference in 10 CFR 50.55a, as well as augmented inspections in accordance to applicant's commitments to NRC GL 80-095 to implement NUREG-0619.	Both of these activities seem to describe the same inspection. If there is a difference between the two, it is not clear. The CRDRL nozzle program requires augmented inspection of the nozzles in accordance with the recommendations of NUREG-0619, and a crack growth fracture mechanics analysis is used to demonstrate the adequacy of the inspection interval. However, the program description does not include the mitigation measures described in program element 2	Include clarification regarding the inspection activities, and add mitigation measures.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.
[2] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	involving the guidance in NUREG-0619 and also water chemistry control to reduce the susceptibility to SCC.	
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP is essentially based on (a) augmented inspection in accordance with the requirements of ASME Section XI, Subsection IWB and the recommendations of NUREG-0619 as well as the applicant's commitments in response to NRC GL 80-095, and (b) mitigation measures documented in NUREG-0619.		
b.1: See comment a.2 above.	For clarity, the mitigation measures documented in NUREG-0619 should be included in the program description.	Add mitigation measures.
Program Consistency and Commitments		
The AMP for NMP-1 plant makes three exceptions to the GALL, Rev. 0, AMP XI.M6 BWR Control Rod Drive Return Line Nozzle program: (a) The NMP-1 program does not comply with the specific ASME Code edition cited in the GALL report because the NMP-1 program is updated to the latest edition and addenda of the ASME Section XI, as mandated in 10 CFR 50.55a. (b) The NMP-1 program uses enhanced UT inspection instead of PT inspections to satisfy the recommendations of NUREG-0619, which is now superseded by Appendix VIII to ASME Section XI, 1995 edition with 1996 addenda. (c) The NMP-1 program uses a 10-year inspection frequency instead of every sixth refueling outage or 90 startup/shutdowns as specified in NUREG-0619.		
c.1: (NMP-1 plant visit) The NMP-1 LRA states that inspection recommendations in NUREG-0619 have been superseded because the inspections are now performed in accordance with ASME Section XI Appendix VIII, which suggests that NMP-1 has invoked alternate rules that superseded NUREG-0619. It is not clear whether the requirements of the NUREG-0619 were invoked, or whether the alternative inspections were performed and NUREG-0619 was used as guidance.	The program description may be revised to clarify that the UT and PT inspections required by NUREG-0619 have been superseded by the alternative inspection guidance, and that augmented inspections are now performed in accordance with ASME Section XI, Appendix VIII.	Include clear guidance regarding the augmented inspection program being recommended.
1. Scope of Program		
The program manages the effects of cracking on the intended pressure boundary function of CRDRL nozzles. The scope of this program is applicable to BWRs whose reactor vessel (RV) design includes a welded CRDRL nozzle design. The scope of the program includes		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
CRDRL nozzles and their nozzle-to-RV welds, which are ASME Code Class 1 components. The scope of the program also includes a CRDRL nozzle cap (including any CRDRL nozzle-to-cap welds) if, to mitigate cracking, an applicant has cut the piping to the CRDRL nozzle, and capped the CRDRL nozzle.		
1.1: No further review item was identified.		
2. Preventive Actions		
Activities for preventing or mitigating cracking in CRDRL nozzles are consistent with a BWR facility's past preventive or mitigation actions/activities in its current licensing basis as stated in the applicant's docketed response to NRC GL 80-095 and made to address the recommendations in NUREG-0619. Maintaining high water purity reduces susceptibility to SCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation, and technical basis of water chemistry are addressed through implementation of GALL AMP XI.M2, "Water Chemistry."		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
The aging management program (AMP) manages the effects of cracking on the intended function of the RV, the CRDRL nozzle, and for capped nozzles, the nozzle caps, and cap-to-nozzle welds. For liquid penetrant test (PT) examinations that are implemented in accordance with this AMP, the AMP monitors for linear indications that may be indicative of surface breaking cracks. For the volumetric ultrasonic test (UT) examinations that are performed in accordance with this AMP, the AMP monitors and evaluates signals that may indicate the presence of a planar flaw (crack).		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
The extent and schedule of inspection, as delineated in NUREG-0619, assures detection of cracks before the loss of intended function of the CRDRL nozzles. Inspection and test recommendations include PT of CRDRL nozzle bend radius and bore regions and the RV wall area beneath the nozzle, control rod drive system performance testing, and for capped nozzles, the nozzle caps and cap-to-nozzle welds. The inspection is to include base metal to a distance of one-pipe-wall thickness or 0.5 inches, whichever is greater, on both sides of the weld.		
4.1: As mentioned above in comment a.2, the inspection frequencies are based on the results of plant-specific crack growth fracture mechanics assessment to demonstrate that small flaws will not grow to unacceptable sizes until the inspection interval for the BWR CRDRL nozzles.	As part of the license renewal, these licensing bases fracture mechanics assessments may need to be updated to be consistent with the recent Codes and Standards, in particular the most recent mathematical relationships for crack growth rates, including the effects of reactor coolant environment. In addition, these analyses may also need to	Revise element 4 of the AMP to include such guidance.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	be updated to include the effects of any plant modification such as EPU, which can change the heat balance of the primary system (temperature, pressure, flow, and steam quality) and this could potentially change the mathematical relationships used for crack growth rate estimation.	
5. Monitoring and Trending		
The inspection schedule of NUREG-0619 provides timely detection of cracks. Indications of cracking are evaluated and trended in accordance with the ASME Code, Section XI, IWB-3100, against applicable acceptance standard criteria that are specified in the ASME Code, Section XI, IWB-3400 or IWB-3500.		
5.1: The inspection schedule is in accordance with NUREG-0619 and, based on the inspection method and techniques, on plant-specific fracture mechanics assessments.	As mentioned above in comment 4.1, the fracture mechanics assessments need to be updated to include the effects of any plant modification such as EPU.	Revise element 5 to include such guidance.
6. Acceptance Criteria		
Any cracking is evaluated in accordance with ASME Code, Section XI, IWB-3100 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3400 and ASME Code, Section XI, IWB-3500.		
6.1: There are 14 AAIs associated with the NRC SER for BWRVIP-74-A. AAI #8 states that the LR applicant should verify that the number of cycles assumed in the original fatigue design is conservative to assure that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, a LR applicant must address environmental fatigue for the components listed in the BWRVIP-74-A report for the license period. These components or locations are closure studs, nozzles, penetrations, safe-ends, vessel support skirt, and vessel external attachments.	As mentioned above, the inspection frequencies are based on the examination results and the results of plant-specific fracture mechanics assessment. As part of the license renewal, these licensing basis fracture mechanics assessments need to be updated to be consistent with the recent Codes and Standards. In addition, to satisfy the recommendations of BWRVIP-74-A, an LR applicant has to update the fatigue usage time-limited aging analyses (TLAAs), including environmental effects, for the components listed in BWRVIP-74-A report (i.e., nozzles and safe ends).	Revise program to ensure that fatigue crack growth and CUF analyses, including environmental effects, are updated.
7. Corrective Actions		
Corrective action is performed in conformance with ASME Code, Section XI, IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the corrective actions.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Cracking of CRDRL nozzle-to-vessel and nozzle-to-cap welds has occurred in several BWR plants (NUREG-0619 and Information Notice 2004-08). The present AMP has been implemented for nearly 30 years and has been found to be effective in managing the effects of cracking on the intended function of CRDRL nozzles.		
10.1: No further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

NRC Letter from D. G. Eisenhut, U.S. Nuclear Regulatory Commission, to R. Gridley, General Electric Company, *forwarding NRC Generic Technical Activity A-10*, January 28, 1980.

NRC Generic Letter 80-095, (Untitled), November 13, 1980.[4]

NRC Generic Letter 81-11, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking (NUREG-0619),* U.S. Nuclear Regulatory Commission, February 29, 1981.[5]

NRC Information Notice 2004-08, *Reactor Coolant Pressure Boundary Leakage Attributable To Propagation of Cracking In Reactor Vessel Nozzle Welds*, U.S. Nuclear Regulatory Commission, April 22, 2004.

NUREG-0619, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking*, U.S. Nuclear Regulatory Commission, November 1980.

[4] This GL forwarded NUREG-0619 to members of the U.S nuclear power industry and requested that licensees owning BWR model reactors provide confirmation of their intent to implement the recommendations of NUREG-0619, as applied to the design of their BWRs.

[5] This GL was issued primarily to provide additional clarification on the contents of the confirmatory response that was requested in NRC GL 80-095.[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

A.7 XI.M7 BWR Stress Corrosion Cracking

The verbatim text of GALL, Rev. 2, AMP XI.M7, BWR Stress Corrosion Cracking, is included in the following worksheet; all blue text is directly transcribed. The source for the information in line items is based on visit NMP-1 plant and is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program to manage intergranular stress corrosion cracking (IGSCC) in boiling water reactor (BWR) coolant pressure boundary piping made of stainless steel (SS) and nickel-based alloy components is delineated in NUREG-0313, Rev. 2, and Nuclear Regulatory Commission (NRC) Generic Letter (GL) 88-01 and its Supplement 1. The material includes base metal and welds. The comprehensive program outlined in NUREG-0313, Rev. 2 and NRC GL 88-01 describes improvements that, in combination, will reduce the susceptibility to IGSCC. The elements to cause IGSCC consist of a susceptible (sensitized) material, a significant tensile stress, and an aggressive environment. Sensitization of nonstabilized austenitic stainless steels containing greater than 0.035 weight percent carbon involves precipitation of chromium carbides at the grain boundaries during certain fabrication or welding processes. The formation of carbides creates a chromium-depleted region that, in certain environments, is susceptible to stress corrosion cracking (SCC). Residual tensile stresses are introduced from fabrication processes, such as welding, surface grinding, or forming. High levels of dissolved oxygen or aggressive contaminants, such as sulfates or chlorides, accelerate the SCC processes. The program includes (a) preventive measures to mitigate IGSCC and (b) inspection and flaw evaluation to monitor IGSCC and its effects. The staff-approved boiling water reactor vessel and internals project (BWRVIP-75-A) report allows for modifications to the inspection extent and schedule described in the GL 88-01 program.		
a.1: The existing XI.M7 - BWR SCC AMPs at some operating plants may be based on older revisions of the GALL report. The most recent (Rev. 2) GALL report cites several updated guidance documents, including NUREG-0313, Rev. 2, BWRVIP-75-A, BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A (as compared to NUREG-0313, Rev. 0, BWRVIP-75, BWRVIP-14, BWRVIP-59, and BWRVIP-60 cited in GALL, Rev. 0).	The differences between the earlier and updated versions of the various BWRVIP documents may affect the overall quality and effectiveness of the AMP, impacting several program elements of AMP XI.M7. The GALL report does not provide any guidance for plants that may have committed to follow earlier versions of the AMP.	Revise the program description to include some guidance for licensees who implemented GALL Rev. 0, AMP.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.2: One of the measures to mitigate IGSCC consists of the use of modified water chemistry and associated chemistry controls. This aspect is not covered in the BWR SCC AMP, but in another AMP (GALL AMP XI.M2, "Water Chemistry").	The interface of this AMP with the GALL AMP XI.M2 is significant and its relevance needs to be noted in the program description.	Update the description to include GALL XI.M2.
a.3: Susceptible material is not the same as "sensitized" material.	The term "susceptible" material is preferred as it covers the IGSCC in non-sensitized materials including nickel-base alloys.	Revise the description.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of its program the description of the guidance in the following basis documents: (a) NUREG-0313, Revision 2 and (b) Generic Letter 88-01 and its Supplement 1, as modified by BWRVIP-75-A (EPRI 1012621).		
b.1: The existing XI.M7 - BWR SCC AMPs at some operating plants may be based on older revisions of the GALL report. The most recent (Rev. 2) GALL report cites several updated guidance documents, including NUREG-0313, Rev. 2, BWRVIP-75-A, BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A (as compared to NUREG-0313, Rev. 0, BWRVIP-75, BWRVIP-14, BWRVIP-59, and BWRVIP-60 cited in GALL, Rev. 0).	These updated basis documents (i.e., BWRVIP documents) are likely to affect the overall quality and effectiveness of the AMP, and also impact various program elements in general. Therefore, the existing AMP should be updated to reflect the updated basis documents. In addition, BWRVIP-62 (EPRI 108705) has been used as a basis to justify inspection relief for BWR Internal Components subjected to Hydrogen Injection chemistry guidelines.	Add a footnote to the program description so as to bring to attention the need for updating the basis.
Program Consistency and Commitments		
This AMP at NMP-1 is based on Rev. 0 of the GALL report (2001), and the SER for NMP-1 LRA showed the AMP to be consistent, requiring no commitments.		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
The program focuses on (a) managing and implementing countermeasures to mitigate IGSCC and (b) performing in-service inspection to monitor IGSCC and its effects on the intended function of BWR piping components within the scope of license renewal. The program is applicable to all BWR piping and piping welds made of austenitic SS and nickel alloy that are 4 inches or larger in nominal diameter containing reactor coolant at a temperature above 93°C (200°F) during power operation, regardless of code classification. The program		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
also applies to pump casings, valve bodies, and reactor vessel attachments and appurtenances, such as head spray and vent components. NUREG-0313, Rev. 2 and NRC GL 88-01, respectively, describe the technical basis and staff guidance regarding mitigation of IGSCC in BWRs. Attachment A of NRC GL 88-01 delineates the staff-approved positions regarding materials, processes, water chemistry, weld overlay reinforcement, partial replacement, stress improvement of cracked welds, clamping devices, crack characterization and repair criteria, inspection methods and personnel, inspection schedules, sample expansion, leakage detection, and reporting requirements.		
1.1: Although the GALL, Rev. 2, AMP XI.M7 scope includes both stainless steel and nickel-based alloys, there appears to be stated, if not actual, belief that the IGSCC of concern is mainly for the (austenitic) stainless steel piping. In addition, the scope should not be limited based on any Code classification of various related components.	The focus and scope of this AMP may be inadvertently limited to less than that intended by GALL and suggested by the observed aging degradation since the early instances of IGSCC in BWR piping are thought to be limited to small-diameter piping in certain safety related systems.	Revise the program description to clearly describe the program scope.
1.2: The scope of program states "Attachment A of NRC GL 88-01 delineates the staff-approved positions regarding materials, processes, water chemistry, weld overlay reinforcement, partial replacement, stress improvement of cracked welds, clamping devices, crack characterization and repair criteria, inspection methods and personnel, inspection schedules, sample expansion, leakage detection, and reporting requirements."	Various plants have taken different approaches to managing IGSCC in BWR coolant pressure boundary piping. For example, Columbia included the use of materials resistant to SCC for component replacement or repairs in accordance with the guidance of GL 88-01, the induction heating stress improvement (IHSI) process for piping welds, and the mechanical stress improvement process (MSIP) for nozzle to safe end or safe end to pipe welds. Cooper has taken similar action for replacement components. However, instead of using GL 88-01 to determine the scope of welds selected for examination, the Cooper plant used a risk-informed methodology approved by the NRC. Therefore, for each plant, a plant-specific assessment of preventive actions must be performed for the subsequent renewal period, which would require a comprehensive list of such actions taken during the life of the plant.	Revise relevant program elements of the AMP to include listing of, and provisions for assessment of, alternative preventive actions.
2. Preventive Actions		
The BWR Stress Corrosion Cracking Program is primarily a condition monitoring program. Maintaining high water purity reduces		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
susceptibility to SCC or IGSCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation and technical basis of water chemistry are addressed through implementation of GALL AMP XI.M2, "Water Chemistry." In addition, NUREG-0313, Rev. 2 and GL 88-01 delineate the guidance for selection of resistant materials and processes that provide resistance to IGSCC such as solution heat treatment and stress improvement processes.		
2.1: The program description states that it includes preventive measures for IGSCC. In contrast, this program element states that the BWR SCC program is primarily a condition monitoring program. The preventive aspect emphasized in the program description, and in the evolution of measures taken by the industry, is not reflected in this "Preventive Actions" description.	While inspection-based monitoring is an important aspect of this AMP, the significance of preventive measures associated with the BWR SCC mitigation actions is relevant to long term operation (LTO) as well. In either case, the description should be consistent with other elements of this AMP.	Add the preventive aspect to the description.
3. Parameters Monitored/Inspected		
The program detects and sizes cracks and detects leakage by using the examination and inspection guidelines delineated in NUREG-0313, Rev. 2, and NRC GL 88-01 or the referenced BWRVIP-75-Aguideline as approved by the NRC staff.		
3.1: No significant concern or further review item was identified.		
4. Detection of Aging Effects		
The extent, method, and schedule of the inspection and test techniques delineated in NRC GL 88-01 or BWRVIP-75-A are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component. Modifications to the extent and schedule of inspection in NRC GL 88-01 are allowed in accordance with the inspection guidance in approved BWRVIP-75-A. The program uses volumetric examinations to detect IGSCC. Inspection can reveal cracking and leakage of coolant. The extent and frequency of inspection recommended by the program are based on the condition of each weld (e.g., whether the weldments were made from IGSCC-resistant material, whether a stress improvement process was applied to a weldment to reduce residual stresses, and how the weld was repaired, if it had been cracked).		
4.1: GALL AMP XI.M7 basis document GL 88-01, with or without the staff-approved BWRVIP-75-A report, continues to provide the best available guidance on IGSCC management; no operating experience is available to verify their continued effectiveness for operating periods beyond 60 years.	An enhanced inspection program for detection of IGSCC may be required to verify the continued effectiveness of the NRC guidance in controlling IGSCC before extending operating periods beyond 60 years. The scope and extent of this enhancement should be based in large part on global and plant-specific operating experience with respect to IGSCC in the systems and components managed by the	Revise the relevant GALL AMP elements to include needed or possible

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	BWR SCC AMP.	enhancement for detection.
5. Monitoring and Trending		
The extent and schedule for inspection, in accordance with the recommendations of NRC GL 88-01 or approved BWRVIP-75-A guidelines, provide timely detection of cracks and leakage of coolant. Indications of cracking are evaluated and trended in accordance with the American Society of Mechanical Engineers (ASME) Code, Section XI, IWA-3000. Applicable and approved BWRVIP-14-A, BWRVIP-59-A, BWRVIP-60-A, and BWRVIP-62 reports provide guidelines for evaluation of crack growth in SSs, nickel alloys, and low-alloy steels. An applicant may use BWRVIP-61 guidelines for BWR vessel and internals induction heating stress improvement effectiveness on crack growth in operating plants.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
Any cracking is evaluated in accordance with ASME Code, Section XI, IWA-3000 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3000, IWC-3000 and IWD-3000 for Class 1, 2 and 3 components, respectively.		
6.1: No significant concern or further review item was identified.		
7. Corrective Actions		
The guidance for weld overlay repair and stress improvement or replacement is provided in NRC GL 88-01. Corrective action is performed in accordance with IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approved processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the confirmation process and administrative controls.		
8.1: No significant concern or further review item was		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Intergranular SCC has occurred in small- and large-diameter BWR piping made of austenitic SS and nickel-base alloys. Cracking has occurred in recirculation, core spray, residual heat removal, CRD return line penetrations, and reactor water cleanup system piping welds (NRC GL 88-01 and NRC Information Notices [INs] 82-39, 84-41, and 04-08). The comprehensive program outlined in NRC GL 88-01, NUREG-0313, Rev. 2, and in the staff-approved BWRVIP-75-A report addresses mitigating measures for SCC or IGSCC (e.g., susceptible material, significant tensile stress, and an aggressive environment). The GL 88-01 program, with or without the modifications allowed by the staff-approved BWRVIP-75-A report, has been effective in managing IGSCC in BWR reactor coolant pressure-retaining components and will adequately manage IGSCC degradation.		
10.1: Under Program Element 10 ("Operating Experience"), AMP XI.M7 states, "The GL 88-01 program, with or without the modifications allowed by the staff approved BWRVIP-75-A report, has been effective in managing IGSCC in BWR reactor coolant pressure-retaining components and will adequately manage IGSCC degradation." Even though these documents continue to provide the best available guidance on IGSCC management, no operating experience is available to verify their continued effectiveness for operating periods beyond 60 years.	An enhanced inspection program may be required (see above Program Element 4 item) to verify the continued effectiveness of the NRC guidance in controlling IGSCC before extending operating periods beyond 60 years.	Revise relevant program elements of the AMP to include possible enhanced inspection program.
10.2: (NMP-1 plant visit) Review of some program self-assessment reports indicates that the HWC system is not meeting industry goals of 98% operability and that the HWC system design changes to enable low-power hydrogen injection may be receiving too limited attention to be effective. In addition, the long-term strategy for electrochemical potential (ECP) monitoring and coupon	The low-power HWC injection capability to improve the HWC availability may be a crucial long-term strategic initiative, particularly if it is expected that relatively short periods of HWC non-availability may allow pre-existing indications to grow even after hydrogen level is returned to service. This limited availability of HWC during certain operating conditions can lower the potential mitigation	Survey the industry-wide experience with HWC availability and assess its impact for

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
testing may need better coordination between chemistry, systems, and design groups/programs.	effect during the period of extended operation.	this AMP in LTO.
10.3: (NMP-1 plant visit) Sulfate spikes due to resin release from demineralizers appear to be present and recorded in plant operating experience. High sulfate levels have the potential for significantly accelerating SCC in BWR piping. Cumulative effect of these intrusions can be significant for adverse impact over the period of extended operation.	Demineralizer resin intrusion can also increase sulfate levels in the reactor coolant and treated water. It would be relevant to include a plant-specific program for demineralizer chemistry control and maintenance as part of the BWR Water Chemistry AMP. Emphasizing the importance of sulfate chemistry control in the GALL Report is recommended.	Raise the concern and need for added attention to controlling the sulfate levels.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Code Case N-504-1, *Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping*, Section XI, Division 1, 1995 edition, ASME Boiler and Pressure Vessel Code – Code Cases – Nuclear Components, American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

BWRVIP-14-A (EPRI 1016569), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2008.

BWRVIP-59-A, (EPRI 1014874), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Nickel-Base Austenitic Alloys in RPV Internals*, Final Report by the Office of Nuclear Reactor Regulation, May 2007.

BWRVIP-60-A (EPRI 108871), *BWR Vessel and Internals Project, Evaluation of Stress Corrosion Crack Growth in Low Alloy Steel Vessel Materials in the BWR Environment*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, June 2003.

BWRVIP-61 (EPRI 112076), *BWR Vessel and Internals Induction Heating Stress Improvement Effectiveness on Crack Growth in Operating Reactors*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, January 29, 1999.

BWRVIP-62 (EPRI 108705), *BWR Vessel and Internals Project, Technical Basis for Inspection Relief for BWR Internal Components with Hydrogen Injection*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, March 7, 2000.

BWRVIP-75-A (EPRI 1012621), *BWR Vessel and Internals Project, Technical Basis for*

NRC Generic Letter 88-01, Revisions to, *Inspection Schedules* (NUREG-0313), Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, October 2005.

NRC Generic Letter 88-01, NRC *Position on IGSCC in BWR Austenitic Stainless Steel Piping*, U.S. Nuclear Regulatory Commission, January 25, 1988; Supplement 1, February 4, 1992.

NRC Information Notice 04-08, *Reactor Coolant Pressure Boundary Leakage Attributable to Propagation of Cracking in Reactor Vessel Nozzle Welds*, U.S. Nuclear Regulatory Commission, April 22, 2004.

NRC Information Notice 82-39, *Service Degradation of Thick Wall Stainless Steel Recirculation System Piping at a BWR Plant*, U.S. Nuclear Regulatory Commission, September 21, 1982.

NRC Information Notice 84-41, *IGSCC in BWR Plants*, U.S. Nuclear Regulatory Commission, June 1, 1984.

NUREG-0313, Rev. 2, *Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping*, W. S. Hazelton and W. H. Koo, U.S. Nuclear Regulatory Commission, 1988.

A.8 XI.M8 BWR Penetrations

The verbatim text of GALL, Rev. 2, AMP XI.M8, BWR Penetrations, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program for boiling water reactor (BWR) vessel instrumentation penetrations, control rod drive (CRD) housing and incore-monitoring housing (ICMH) penetrations and standby liquid control (SLC) nozzles/Core ΔP nozzles includes inspection and flaw evaluation in conformance with the guidelines of staff-approved boiling water reactor vessel and internals project (BWRVIP)Topical Reports BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A. The inspection and evaluation guidelines of BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A contain generic guidelines intended to present appropriate inspection recommendations to assure safety function integrity. The guidelines of BWRVIP-49-A provide information on the type of instrument penetration, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-47-A provide information on components located in the lower plenum region of BWRs, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-27-A are applicable to plants in which the SLC system injects sodium pentaborate into the bottom head region of the vessel (in most plants, as a pipe within a pipe of the core plate ΔP monitoring system). The BWRVIP-27-A guidelines address the region where the ΔP and SLC nozzle or housing penetrates the vessel bottom head and include the safe ends welded to the nozzle or housing. Guidelines for repair design criteria are provided in BWRVIP- 57-A for instrumentation penetrations and BWRVIP-53-A for SLC line. Although this is a condition monitoring program, control of water chemistry helps prevent stress corrosion cracking (SCC) and intergranular stress corrosion cracking (IGSCC). The water chemistry program for BWRs relies on monitoring and control of reactor water chemistry based on industry guidelines, such BWRVIP-190 (Electric Power Research Institute [EPRI] 1016579) or later revisions.BWRVIP-190 has three sets of guidelines: one for primary water, one for condensate and feedwater, and one for control rod drive (CRD) mechanism cooling water. Adequate aging management activities for these components provide reasonable assurance that the long-term integrity and safe operation of BWR vessel instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations and SLC nozzles/Core ΔP nozzles.		
a.1: The program description for XI.M8 AMP in Rev. 2 of the GALL report does not include the objective of the program (i.e., which aging effects caused by what aging	Although the purpose of the AMP is described in Program Element 1 “Scope of Program,” the program description should include the purpose of the AMP, and state clearly	Update program description to

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
degradation mechanisms are being managed by this AMP). This is the most important component of the program description and should be clearly described in this section.	that this program is focused on managing the effects of cracking due to cyclic loading and SCC, including IGSCC, in BWR attachments.	include the objective.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP for BWR penetrations is essentially based on (a) the inspection and flaw evaluation guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP-27-A, and (b) reactor coolant water chemistry control in accordance with BWRVIP-190 (EPRI 1016579).		
b.1: (NMP-1 plant visit) All three of the program basis BWRVIP documents have AAIs associated with their NRC SERs. The applicants are required to address these AAIs in Appendix C of their LRAs. The components and associated BWRVIP documents are as follows: SLC nozzles/core plate ΔP nozzles, BWRVIP-27-A; lower plenum components, BWRVIP-47-A; and instrument penetration, BWRVIP-49-A.	The guidance of these BWRVIP documents must be implemented by all BWR licensees. Site procedures require a technical justification to be documented, and the NRC to be notified, for any deviation from the guidelines. To ensure compliance, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP reports referenced in the AMP. Some significant AAIs may be listed.	Include guidance for applicant to address all AAIs related to BWRVIP reports referenced in the AMP.
Program Consistency and Commitments		
The NMP-1 program is consistent with GALL AMP XI.M8, Rev. 0. However, the GALL, Rev. 0, program is not the same as the GALL, Rev. 2, program; it does not refer to BWRVIP-47-A as a program basis document.		
c.1: (NMP-1 plant visit) The guidelines in BWRVIP-49 provide information on the type of instrument penetration, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-27 are applicable to plants in which the SLC system injects sodium pentaborate into the bottom head region of the vessel (typically, as a pipe within the pipe of core plate differential pressure [DP] monitoring system). These guidelines address the region where the DP and SLC nozzle or housing penetrates the vessel bottom head and include the safe ends welded to the nozzle or housing.	Although the BWRVIP-47-A document, which addresses the BWR lower plenum inspection and evaluation, including CRD stub tubes, is not referenced in the NMP-1 program basis document, the inspection and evaluation guidelines in BWRVIP-47-A have been implemented as part of the BWR vessel internals program; therefore, in effect, the licensee has implemented the AMAs in accordance with BWRVIP-47-A. For licensees who may have implemented GALL, Rev. 0, AMP, it would be useful to include some clarification that for subsequent license renewal (SLR), all applicants must implement the GALL, Rev. 2, AMP.	Update the program description and Element 4 to include some clarification for licensees who implemented the GALL, Rev. 0, AMP.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1. Scope of Program		
The scope of this program is applicable to BWR instrumentation penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR SLC nozzles/Core ΔP nozzles. The program manages cracking due to cyclic loading or SCC and IGSCC using inspection and flaw evaluation in accordance with the guidelines of staff-approved BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A.		
1.1: The scope of program states that this program is applicable to BWR instrumentation penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations, and BWR SLC nozzles/Core ΔP nozzles. However, it does not identify the material of these components as SS or nickel alloy.	Information on type and composition of component material should be included in the scope of program since the mitigation actions described next in preventive actions depend on the degradation associated with the type of the material and its environment in the reactor. For example, for Ni alloys, fatigue crack initiation in HWC is significantly faster than in NWC, and susceptibility to SCC may not decrease in HWC for some Ni alloy welds (e.g., sensitized welds or under crevice conditions). See Comment 2.1.	Revise the scope of program to include information on the material of these components.
2. Preventive Actions		
This program is a condition monitoring program and has no preventive actions. However, maintaining high water purity reduces susceptibility to SCC or IGSCC. The program description, evaluation and technical basis of water chemistry are presented in GALL AMP XI.M2, "Water Chemistry."		
2.1: This program element states, "maintaining high water purity reduces susceptibility SCC or IGSCC." In addition, the licensee stated that OE supports the effectiveness of HWC/NMCA on the mitigation of IGSCC in sensitized stainless steel and Alloy 182. However, these statements are not true for Ni-alloy welds.	Decreasing the corrosion potential of the coolant environment may not necessarily be beneficial for Ni alloys. In fact, for Ni alloys, fatigue crack initiation is faster when the water corrosion potential is decreased, and the susceptibility to SCC may not decrease for some Ni alloy welds (e.g., sensitized welds or under crevice conditions). This program element should be revised to include clarification regarding the different behavior of HWC on SCC susceptibility and fatigue crack initiation in Ni-alloys. In addition, some other mitigation measures, such as using more resistant materials and weld metal (e.g.,	Revise Element 2 to include clarification regarding SCC susceptibility of Ni alloys in HWC and mitigation measures.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	Alloy 82 instead of Alloy 1820) or protective coating, may be included in the program.	
2.2: (NMP-1 plant visit) The NMP-1 plant is currently operating under HWC/NMCA to mitigate IGSCC. However, water chemistry guidelines in EPRI TR-103515-R0 recommend that hydrogen injection and sampling frequencies and action levels for feedwater iron and copper commence at 10% power. The NMP-1 plant makes an exception to this guideline; these sampling activities do not commence until 30% power because the filter samples collected below 30% power are not representative and the operating time between 10% and 30% power is relatively short and considered insignificant.	The non-availability of HWC may allow preexisting in-vessel cracks to grow or new cracks to initiate. A modification to make HWC available and effective at low power is scheduled for 2013. For LTO, it would be advisable to monitor the periods of operation without HWC and, periodically or when deemed necessary, update any crack growth fracture mechanics analyses or fatigue usage analyses to demonstrate their validity.	Revise Element 2 of the AMP to include such guidance.
3. Parameters Monitored/Inspected		
The program manages the effects of cracking due to SCC/IGSCC on the intended function of the BWR instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations, and BWR SLC nozzles/Core ΔP nozzles. The program accomplishes this by inspection for cracks in accordance with the NUREG-1801, Rev. 2 XI M8-2 December 2010 guidelines of approved BWRVIP-49-A, BWRVIP-47-A or BWRVIP-27-A and the requirements of the ASME Code, Section XI, Table IWB 2500-1 (2004 edition[2]).		
3.1: (NMP-1 plant visit) The GALL, Rev. 0, AMP includes the following relief: An applicant may use the guidelines in BWRVIP-62 for inspection relief for vessel internal components with HWC. However, the applicant stated that the BWRVIP-62 guidelines are not being applied to NMP-1. Although NMP-1 utilizes HWC, it is conservatively not credited for inspection relief.	The guidelines of BWRVIP-62 for inspection relief have been deleted from GALL, Rev. 2. Reliefs are on a case-by-case basis. Licensees can request relief under 10 CFR 50.55a(a)(3) for the use of HWC; such a relief is approved only for a 10-year interval. While operating under HWC, since <u>inspection relief under 10 CFR 50.55a(a)(3) in accordance with the guidelines in BWRVIP-62 is approved on a case-by-case basis, and only for 10 years</u>, it would be prudent to add the above underlined information in this program element for those licensees who may have requested inspection relief earlier	Revise Element 3 to include clarification for the difference between GALL and BWRVIP inspection guidance.

[2] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	when operating under HWC.	
4. Detection of Aging Effects		
The evaluation guidelines of BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A provide that the existing inspection requirements in ASME Code, Section XI, Table IWB-2500-1, are sufficient to monitor for indications of cracking in BWR instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR SLC nozzles/Core ΔP nozzles, and should continue to be followed for the period of extended operation. The extent and schedule of the inspection and test techniques prescribed by the ASME Code, Section XI program are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component. Instrument penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and SLC system nozzles or housings are inspected in accordance with the requirements in the ASME Code, Section XI. These examination categories include volumetric examination methods (ultrasonic testing or radiography testing), surface examination methods (liquid penetrant testing or magnetic particle testing), and VT-2 visual examination methods.		
4.1: The licensee currently relies on the roll-expansion repair method in accordance with ASME Code Case N-730, and is seeking NRC approval for deviations from the requirements of ASME Code Case N-606-1 for CRD stub tube weld repair. However, in the event roll-expansion repair does not prevent leakage, the licensee is also working to get NRC approval for a weld repair method of Code Case N-606-1 and BWRVIP-58. The Code Case N-606-1 provides the requirements for performing a dissimilar metal weld repair without preheat and post soak heat treatments on the reactor vessel and CRD housing interface.	For LTO, the detection of aging effects program element of the GALL AMP may be revised to include the recent guidance for stub tube weld repair activities.	Revise Element 4 to include such guidance.
5. Monitoring and Trending		
Inspections scheduled in accordance with ASME Code, Section XI, IWB-2400 and approved BWRVIP-49-A, BWRVIP-47-A, or BWRVIP-27-A provides timely detection of cracks. The scope of examination and reinspection is expanded beyond the baseline inspection if flaws are detected. Any indication detected is evaluated in accordance with ASME Code, Section XI or other acceptable flaw evaluation criteria, such as the staff-approved BWRVIP-49-A, BWRVIP-47-A, or BWRVIP-27-A guidelines. Applicable and approved BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A documents provide additional guidelines for the evaluation of crack growth in stainless steels (SSs), nickel alloys, and low-alloy steels, respectively.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
5.1: No further review item was identified.		
6. Acceptance Criteria		
Acceptance criteria are given in BWRVIP-49-A for instrumentation nozzles, BWRVIP-47-A for CRD housing and incore-monitoring housing (ICMH) penetrations, and BWRVIP-27A for BWR SLC nozzles/Core ΔP nozzles.		
6.1: No further review item was identified.		
7. Corrective Actions		
Repair and replacement procedures in staff-approved BWRVIP-57-A and BWRVIP-53-A are equivalent to those required in ASME Code, Section XI. Guidelines for repair design criteria are provided in BWRVIP-57-A for instrumentation penetrations and BWRVIP-53-A for SLC line. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP- 27-A provides an acceptable level of quality in accordance with 10 CFR Part 50, Appendix B corrective actions. However, any repair in accordance with ASME Code is acceptable.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP-27A, as modified, provides an acceptable level of quality for inspection and flaw evaluation of the safety-related components addressed in accordance with the 10 CFR Part 50, Appendix B confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Cracking due to SCC or IGSCC has occurred in BWR components made of austenitic SSs and nickel alloys. The program guidelines are based on an evaluation of available information, including BWR inspection data and information about the elements that cause IGSCC, to determine which locations may be susceptible to cracking. Implementation of the program provides reasonable assurance that cracking will be adequately managed so the intended functions of the instrument penetrations and SLC system nozzles or housings will be		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
maintained consistent with the current licensing basis for the period of extended operation.		
10.1: At NMP-1, the licensee stated that, as of 2008, 33 out of the 129 CRD penetration stub tubes have been repaired by roll expansion to a nominal 4% wall thinning. Of these, only one penetration (50-19) has been re-roll expanded to 6% wall thinning, due to repeated occurrence of leakage. The licensee further stated that BWRVIP-03 EVT-1 visual inspection has been effective to detect IGSCC in CRD stub tubes except for stub tube 50-19. The reason for poor inspection performance (during RFO 15) was that 20% of the inspection areas of the stub-to-vessel weld of the penetration did not have adequate lighting and camera angle. In addition, the licensee stated that the stub tubes were furnace-sensitized and, therefore, were susceptible to IGSCC, and that the shorter stub tubes located around the perimeter of the bottom head were more susceptible to IGSCC than the longer stub tubes in the center. The licensee stated that no leaks related to stub tube degradation have been observed since NMP-1 entered the period of extended operation, or since the roll expansion of penetration 50-19.	The licensee currently relies on the roll-expansion repair method in accordance with ASME Code Case N-730. However, in the event roll-expansion repair does not prevent leakage, the licensee is working proactively to get NRC approval for a weld repair method based on ASME Code Case N-606-1 and BWRVIP-58. The Code Case N-606-1 provides the requirements for performing a dissimilar metal weld repair without preheat and post soak heat treatments on the reactor vessel and CRD housing interface. The licensee also stated that the IGSCC cracks were observed in the heat-affected zone (HAZ) of the stub tubes adjacent to the stub-tube-to-housing weld, which should be a stainless steel weld (Type 304L). This is a notable OE; IGSCC was observed in the stub tube HAZ adjacent to the housing weld and not the dissimilar-metal weld (Alloy 182) between the vessel and the stub tube. This information may be significant and should be included in this program element. In addition, the corrective actions, root cause analyses performed by the applicant to resolve the stub tube cracking, and preemptive actions to develop alternative weld repair techniques are considered a good practice or strength of the AMP.	Revise Program Element 10 to include this information.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

BWRVIP-14-A (EPRI 1016569), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2008.

BWRVIP-27-A (EPRI 1007279), *BWR Vessel and Internals Project, BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, August 2003.

BWRVIP-47-A (EPRI 1009947), *BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, November 2004.

BWRVIP-49-A (EPRI 1006602), *BWR Vessel and Internals Project, Instrument Penetration Inspection and Flaw Evaluation Guidelines*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation.

BWRVIP-53-A (EPRI 1012120), *BWR Vessel and Internals Project, Standby Liquid Control Line Repair Design Criteria*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2005.

BWRVIP-57-A (EPRI 1012111), *BWR Vessel and Internals Project, Instrument Penetration Repair Design Criteria*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2005.

BWRVIP-59-A (EPRI 1014874), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Nickel-Base Austenitic Alloys in RPV Internals*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, May 2007.

BWRVIP-60-A (EPRI 1008871), *BWR Vessel and Internals Project, Evaluation of Stress Corrosion Crack Growth in Low Alloy Steel Vessel Materials in the BWR Environment*, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, June 2003.

BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project, BWR Water Chemistry Guidelines*-2008 Revision, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, October 2008.

A.9 XI.M9 BWR Vessel Internals

The verbatim text of GALL, Rev. 2, AMP XI.M9, BWR Vessel Internals, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program includes inspection and flaw evaluations in conformance with the guidelines of applicable and staff-approved boiling water reactor vessel and internals project (BWRVIP) documents to provide reasonable assurance of the long-term integrity and safe operation of boiling water reactor (BWR) vessel internal components. The BWRVIP documents provide generic guidelines intended to present the applicable inspection recommendations to assure safety function integrity of the subject safety-related reactor pressure vessel internal components. The guidelines provide information on component description and function; evaluate susceptible locations and safety consequences of failure; provide recommendations for methods, extent, and frequency of inspection; discuss acceptable methods for evaluating the structural integrity significance of flaws detected during these examinations; and recommend repair and replacement procedures. In addition, this program provides screening criteria to determine the susceptibility of cast austenitic stainless steels (CASS) components to thermal aging on the basis of casting method, molybdenum content, and percent ferrite, in accordance with the criteria set forth in the May 19, 2000 letter from Christopher Grimes, Nuclear Regulatory Commission (NRC), to Mr. Douglas Walters, Nuclear Energy Institute (NEI). The susceptibility to thermal aging embrittlement of CASS components is determined in terms of casting method, molybdenum content, and ferrite content. For low-molybdenum content steels (SA-351 Grades CF3, CF3A, CF8, CF8A, or other steels with ≤0.5 wt.% molybdenum), only static-cast steels with >20% ferrite are potentially susceptible to thermal embrittlement. Static-cast low-molybdenum steels with >20% ferrite and all centrifugal-cast low-molybdenum steels are not susceptible. For high-molybdenum content steels (SA-351 Grades CF3M, CF3MA, CF8M or other steels with 2.0 to 3.0 wt.% molybdenum), static-cast steels with >14% ferrite and centrifugal-cast steels with >20% ferrite are potentially susceptible to thermal embrittlement. Static-cast high-molybdenum steels with ≤14% ferrite and centrifugal-cast high-molybdenum steels with ≤20% ferrite are not susceptible. In the susceptibility screening method, ferrite content is calculated by using the Hull's equivalent factors (described in NUREG/CR-4513, Rev. 1) or a staff approved method for calculating delta ferrite in CASS materials. The screening criteria are applicable to all cast stainless steel primary pressure boundary and reactor vessel internal components with service conditions above 250°C (482°F). The screening criteria for susceptibility to thermal aging embrittlement are not applicable to niobium-containing steels; such steels require evaluation on a case-by-case basis. For "potentially susceptible" components, the program considers loss of fracture toughness due to neutron embrittlement or thermal aging embrittlement. This AMP addresses aging degradation of X-750 alloy-, and precipitation-hardened (PH) martensitic stainless steel (e.g., 15-5 and 17-4 PH steel) materials and martensitic stainless steel (e.g., 403, 410, 431 steel) that are used in BWR vessel internal components. When exposed to a BWR reactor temperature of 550°F, these materials can experience neutron embrittlement and a decrease in fracture toughness. PH-martensitic stainless steels and martensitic stainless steels are also susceptible to thermal embrittlement. Effects of thermal and neutron embrittlement can cause failure of these materials in vessel internal components. In addition, X-750 alloy in a BWR		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
environment is susceptible to intergranular stress corrosion cracking (IGSCC).		
a.1: The program description for XI.M9 AMP in Rev. 2 of the GALL report does not include the objective of the program. The program description does not state which aging effects caused by what aging degradation mechanisms are being managed by this AMP. This is the most important component of the program description and should be clearly described in this section.	The program description should state that the AMP manages the following aging effects/aging mechanisms: cracking due to SCC, IGSCC, or IASCC; loss of fracture toughness due to thermal embrittlement and/or neutron embrittlement; loss of material due to wear (jet pump wedge surface); and cracking due to flow-induced vibrations (steam dryer).	Revise the program description to include the objective.
a.2: (NMP-1 plant visit) The program to manage loss of fracture toughness of CASS reactor internal components due to thermal aging embrittlement and neutron embrittlement is essentially per AMP XI.M13 of GALL, Rev. 1, and is acceptable.	The program description of this AMP XI.M9 does not include an important component of the GALL, Rev. 1, AMP XI.M13, that the synergistic effects of thermal and neutron embrittlement should be addressed in the program.	Include the missing component of the CASS AMP.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP for BWR vessel internals essentially implements the inspection and evaluation guidance provided in 10 primary BWRVIP documents (and several other supporting BWRVIP documents) for the following 10 vessel internal components: core shroud, core plate, core spray, shroud support, jet pump assembly, low-pressure coolant injection (LPCI), top guide, control rod drive (CRD) housing, lower plenum components, and steam dryer. These documents are listed in the scope of program described below.		
b.1: (NMP-1 plant visit) Seven of these ten BWRVIP documents have AAIs associated with their NRC SERs. The applicants are required to address these AAIs in Appendix C of its LRAs. The components and associated BWRVIP documents are as follows: core plate, BWRVIP-25; core spray, BWRVIP-18-A; shroud support, BWRVIP-38; jet pump assembly, BWRVIP-41; LPCI coupling, BWRVIP-42-A; top guide, BWRVIP-26-A and BWRVIP-183; and lower plenum components, BWRVIP-47-A.	The guidance in these BWRVIP documents must be implemented by all BWR licensees. For any deviation from the guidelines, the site procedures require the technical justification to be documented, and the NRC to be notified. To ensure compliance, the program description or scope of program should include guidance for the applicant to address all AAIs associated with the BWRVIP reports referenced in the AMP. Some significant AAIs may be listed.	Include guidance for the applicant to address all AAIs related to BWRVIP reports referenced in the AMP.
Program Consistency and Commitments		
The AMP for NMP-1 listed several enhancements to make its existing AMP consistent with the GALL, Rev. 0, AMP XI.M9 BWR Vessel Internals program.		
c.1: (NMP-1 plant visit) The NMP-1 procedure documents	The applicant's procedure documents do not include other	Revise the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
implement the commitments to NRC to manage the effects of aging degradation on reactor internal components. However, these documents mention only cracking due to IGSCC, IASCC, or fatigue loading.	aging effects such as loss of fracture toughness due to thermal aging and/or neutron embrittlement or loss of material due to wear, which, according to the GALL report, are also being managed by this AMP. See comment a.1 above.	program description to include the objective.

1. Scope of Program

The program is focused on managing the effects of cracking due to stress corrosion cracking (SCC), IGSCC, or irradiation-assisted stress corrosion cracking (IASCC), cracking due to fatigue and loss of material due to wear. This program also includes loss of toughness due to neutron and thermal embrittlement. The program applies to wrought and cast reactor vessel internal components. The program contains in-service inspection (ISI) to monitor the effects of cracking on the intended function of the components, uses NRC-approved BWRVIP reports as the basis for inspection, evaluation, repair and/or replacement, as needed, and evaluates the susceptibility of CASS, X-750 alloy, precipitation-hardened (PH) martensitic stainless steel (e.g., 15-5 and 17-4 PH steel), and martensitic stainless steel (e.g., 403, 410, 431 steel) components to neutron and/or thermal embrittlement.

The scope of the program includes the following BWR reactor vessel (RV) and RV internal components as subject to the following NRC-approved applicable BWRVIP guidelines:

Core shroud: BWRVIP-76-A provides guidelines for inspection and evaluation; BWRVIP-02-A, Rev. 2, provides guidelines for repair design criteria.

Core plate: BWRVIP-25 provides guidelines for inspection and evaluation; BWRVIP-50-A provides guidelines for repair design criteria.

Core spray: BWRVIP-18-A provides guidelines for inspection and evaluation; BWRVIP-16-A and 19A provides guidelines for replacement and repair design criteria, respectively.

Shroud support: BWRVIP-38 provides guidelines for inspection and evaluation; BWRVIP-52-A provides guidelines for repair design criteria.

Jet pump assembly: BWRVIP-41 provides guidelines for inspection and evaluation; BWRVIP-51-A provides guidelines for repair design criteria.

Low-pressure coolant injection (LPCI) coupling: BWRVIP-42-A provides guidelines for inspection and evaluation; BWRVIP-56-A provides guidelines for repair design criteria.

Top guide: BWRVIP-26-A and BWRVIP-183 provide guidelines for inspection and evaluation; BWRVIP-50-A provides guidelines for repair design criteria. Inspect five percent (5%) of the top guide locations using enhanced visual inspection technique, EVT-1 within six years after entering the period of extended operation. An additional 5% of the top guide locations will be inspected within twelve years after entering the period of extended operation.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Reinspection Criteria: BWR/2-5 - Inspect 10% of the grid beam cells containing control rod drives/blades every twelve years with at least 5% to be performed within six years. BWR/6 - Inspect the rim areas containing the weld and heat affected zone (HAZ) from the top surface of the top guide and two cells in the same plane/axis as the weld every six years. The top guide inspection locations are those that have high neutron fluences exceeding the IASCC threshold. The extent of the examination and its frequency will be based on a ten percent sample of the total population, which includes all grid beam and beam-to-beam crevice slots. *Control rod drive (CRD) housing:* BWRVIP-47-A provides guidelines for inspection and evaluation; BWRVIP-58-A provides guidelines for repair design criteria. *Lower plenum components:* BWRVIP-47-A provides guidelines for inspection and evaluation; BWRVIP-57-A provides guidelines for repair design criteria for instrument penetrations. *Steam Dryer*: BWRVIP-139 provides guidelines for inspection and evaluation for the steam dryer components. Although BWRVIP repair design criteria provide criteria for repairs, aging management strategies for repairs are provided by the repair designer, not the BWRVIP.		
1.1: See comment b.1 above.		
2. Preventive Actions		
The BWR Vessel Internals Program is a condition monitoring program and has no preventive actions. Maintaining high water purity reduces susceptibility to SCC or IGSCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation and technical basis of water chemistry are presented in GALL AMP XI.M2, "Water Chemistry." In addition, for core shroud repairs or other IGSCC repairs, the program maintains operating tensile stresses below a threshold limit that precludes IGSCC of X-750 material.		
2.1: (NMP-1 plant visit) The NMP-1 plant is currently operating under HWC and noble metal chemical additions (NMCA) to mitigate IGSCC. However, water chemistry guidelines in EPRI TR-103515-R0 recommend that hydrogen injection and sampling frequencies and action levels for feedwater iron and copper commence at 10% power. NMP-1 makes an exception to this guideline; these	The unavailability of HWC may allow preexisting in-vessel cracks to grow or new cracks to initiate. For LTO, it would be advisable to monitor the periods of operation without HWC and, periodically or when deemed necessary, update any crack growth fracture mechanics analyses or fatigue usage analyses to	Revise Element 2 of the AMP to include such guidance.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
sampling activities do not commence until 30% power, because the filter samples collected below 30% power are not representative and the operating time between 10% and 30% power is relatively short and considered insignificant.	demonstrate their validity.	
2.2: The preventive actions program element of the GALL AMP states, "for core shroud repairs or other IGSCC repairs, the program maintains operating tensile stresses below a threshold limit that precludes IGSCC of X-750 material."	The GALL report does not qualify this statement by including a reference document that provides further details regarding the threshold stress (i.e., the basis for defining this threshold stress and the associated material and environment conditions). Such information must be included in this program element, particularly when the OE program element states, "IGSCC in the X-750 materials of a tie rod coupling and jet pump hold-down beam was observed in a domestic plant."	Mitigation action regarding the use of X-750 should either be justified or deleted.
3. Parameters Monitored/Inspected		
The program monitors the effects of cracking on the intended function of the component by detection and sizing of cracks by inspection in accordance with the guidelines of applicable and approved BWRVIP documents and the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Table IWB 2500-1 (2004 edition[2]). Loss of fracture toughness due to neutron embrittlement in CASS materials can occur with a neutron fluence greater than $1x10^{17}$ n/cm^2 (E>1 MeV). Loss of fracture toughness of CASS material due to thermal embrittlement is dependent on the material's casting method, molybdenum content, and ferrite content. The program does not directly monitor for loss of fracture toughness that is induced by thermal aging or neutron irradiation embrittlement. The impact of loss of fracture toughness on component integrity is indirectly managed by using visual or volumetric examination techniques to monitor for cracking in the components. Neutron embrittlement of X-750 alloys, PH-martensitic stainless steels, and martensitic stainless steels cannot be identified by typical in-service inspection activities. However, by performing visual or other inspections, applicants can identify cracks that could lead to failure of a potentially embrittled component prior to component failure. Applicants can thus indirectly manage the effects of embrittlement in the PH steels, martensitic stainless steels, and X-750 components by identifying aging degradation (i.e., cracks), implementing early corrective actions, and monitoring and trending age-related degradation.		
3.1: (NMP-1 plant visit) The program primarily monitors the	The total neutron dose is likely to exceed the threshold	Revise

[2] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
effect of cracking on the intended function of the reactor internal components by detecting and sizing cracks by inspection. However, with continued operation the total accumulated neutron dose also continues to increase. For example, the best-estimate neutron fluence for the top guide was 4.4×10^{21} n/cm^2 (6.6 dpa) at the time of the top guide UT examination performed in 2005.	levels for susceptibility to IASCC, neutron embrittlement, or stress relaxation for several reactor internal components. It would be prudent to monitor the total dose of a select set of components to identify the potential for IASCC susceptibility, neutron embrittlement, stress relaxation of bolted components, so that the management activities needed to adequately manage these aging degradations can be defined.	Element 3 to include an assessment of degradation processes based on total neutron dose.

4. Detection of Aging Effects

The extent and schedule of the inspection and test techniques prescribed by the applicable and NRC-approved BWRVIP guidelines are designed to maintain structural integrity and ensure that aging effects will be discovered and repaired before the loss of intended function of BWR vessel internals. Inspection can reveal cracking. Vessel internal components are inspected in accordance with the requirements of ASME Section XI, Subsection IWB, Examination Category B-N-2. The ASME Section XI inspection specifies visual VT-1 examination to detect discontinuities and imperfections, such as cracks, corrosion, wear, or erosion, on the surfaces of components. This inspection also specifies visual VT-3 examination to determine the general mechanical and structural condition of the component supports by (a) verifying parameters, such as clearances, settings, and physical displacements, and (b) detecting discontinuities and imperfections, such as loss of integrity at bolted or welded connections, loose or missing parts, debris, corrosion, wear, or erosion. BWRVIP program requirements provide for inspection of BWR reactor internals to manage loss of material and cracking using appropriate examination techniques such as visual examinations (e.g., EVT-1, VT-1) and volumetric examinations (e.g., UT).

The applicable and NRC-approved BWRVIP guidelines recommend more stringent inspections, such as EVT-1 examinations or ultrasonic methods of volumetric inspection, for certain selected components and locations. The nondestructive examination (NDE) techniques appropriate for inspection of BWR vessel internals, including the uncertainties inherent in delivering and executing NDE techniques in a BWR, are included in BWRVIP-03.

Thermal and/or neutron embrittlement in susceptible CASS, PH-martensitic steels, martensitic stainless steels, and X-750 components are indirectly managed by performing periodic visual inspections capable of detecting cracks in the component. The 10-year ISI program during the renewal period may include a supplemental inspection covering portions of the susceptible components determined to be limiting from the standpoint of thermal aging susceptibility, neutron fluence, and cracking susceptibility (i.e., applied stress, operating temperature, and environmental conditions). The inspection technique is capable of detecting the critical flaw size with adequate margin. The critical flaw size is determined based on the service loading condition and service-degraded material properties. One example of a supplemental examination is VT-1 examination of ASME Code, Section XI, IWA-2210. The initial inspection is performed either prior to or within 5 years after entering the period of extended operation. If cracking is detected after the initial inspection, the frequency of re-inspection should be justified by the applicant based on fracture toughness properties appropriate for the condition of the component. The

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sample size is 100% of the accessible component population, excluding components that may be in compression during normal operations.		
4.1: No further review item was identified.		
5. Monitoring and Trending		
Inspections are scheduled in accordance with the applicable and approved BWRVIP guidelines provide timely detection of cracks. Each BWRVIP guideline recommends baseline inspections that are used as part of data collection towards trending. The BWRVIP guidelines provide recommendations for expanding the sample scope and re-inspecting the components if flaws are detected. Any indication detected is evaluated in accordance with ASME Code, Section XI or the applicable BWRVIP guidelines. BWRVIP-14-A, BWRVIP-59-A, BWRVIP-60-A, BWRVIP-80NP-A and BWRVIP-99-A documents provide additional guidelines for evaluation of crack growth in stainless steels (SSs), nickel alloys, and low-alloy steels, respectively. Inspections scheduled in accordance with ASME Code, Section XI, IWB-2400 and reliable examination methods provide timely detection of cracks. The fracture toughness of PH-martensitic steels, martensitic stainless steels, and X-750 alloys susceptible to thermal and/or neutron embrittlement need to be assessed on a case-by-case basis.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Acceptance criteria are given in the applicable BWRVIP documents or ASME Code, Section XI. Flaws detected in CASS components are evaluated in accordance with the applicable procedures of ASME Code, Section XI, IWB-3500. Flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with ASME Code, Section XI, IWB-3640 procedures for SAWs, disregarding the ASME Code restriction of 20% ferrite. Extensive research data indicate that the lower-bound fracture toughness of thermally aged CASS materials with up to 25% ferrite is similar to that for SAWs with up to 20% ferrite (Lee et al., 1997). Flaw evaluation for CASS components with >25% ferrite is performed on a case-by-case basis by using fracture toughness data provided by the applicant. A fracture toughness value of 255 kJ/m^2 (1,450 in.-lb./in.^{2}) at a crack depth of 2.5 mm (0.1 in.) is used to differentiate between CASS materials that are susceptible to thermal aging embrittlement and those that are not. Extensive research data indicate that for non-susceptible CASS materials, the saturated lower-bound fracture toughness is greater than 255 kJ/m^2 (NUREG/CR-4513, Rev. 1). Acceptance criteria for the assessment of PH-martensitic steels, martensitic stainless steels, and X-750 alloys susceptible to thermal aging and/or neutron embrittlement are assessed on a case-by-case basis.		
6.1: As stated above, the acceptance criteria for this program are in accordance to applicable BWRVIP documents or ASME Code Section XI. However, the report, BWRVIP-100-A, which provides guidance for	This AMP basically follows the ASME Section XI 10-year inspection interval for all highly irradiated reactor vessel internal components. Recent data indicate that exposure to neutron irradiation of 5–8 dpa decreases the fracture	Include the validation of the 10-year inspection

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
estimating the loss of fracture toughness due to neutron embrittlement, is not referenced in this AMP. Such information is needed for flaw tolerance analyses for continued operation of a component or for validating the adequacy of the ASME Section XI, 10-year inspection interval.	toughness J_{Ic} value of stainless steels from well above 200 kJ/m^2 to as low as 7.5 kJ/m^2 (or K_{Jc} of 38 MPa m$^{1/2}$) (NUREG/CR-7027, Dec. 2010). In view of significant reduction in fracture toughness and very high SCC and fatigue crack growth rates, the applicant should validate the 10-year inspection interval. Furthermore, the potential effect of plant modifications such as EPU on flaw tolerance analyses should also be evaluated.	interval for highly irradiated components, including a consideration of plant modifications.
7. Corrective Actions		
Repair and replacement procedures are equivalent to those requirements in ASME Code Section XI. Repair and replacement is performed in conformance with the applicable and NRC-approved BWRVIP guidelines listed above. For top guides where cracking is observed, sample size and inspection frequencies are increased. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the corrective action guidelines in the staff-approved BWRVIP reports will provide an acceptable level of quality accordance with 10 CFR Part 50, Appendix B.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in the staff-approved BWRVIP reports will provide an acceptable level of quality for inspection and flaw evaluation of the safety-related components addressed in accordance with the 10 CFR Part 50, Appendix B, confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
There is documentation of cracking in both the circumferential and axial core shroud welds, and in shroud supports. Extensive cracking of circumferential core shroud welds has been documented in NRC Generic Letter 94-03 and extensive cracking in vertical core shroud		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
welds has been documented in NRC Information Notice 97-17. It has affected shrouds fabricated from Type 304 and Type 304L SS, which is generally considered to be more resistant to SCC. Weld regions are most susceptible to SCC, although it is not clear whether this is due to sensitization and/or impurities associated with the welds or the high residual stresses in the weld regions. This experience is reviewed in NRC GL 94-03 and NUREG-1544; some experiences with visual inspections are discussed in NRC IN 94-42. Both circumferential (NRC IN 88-03) and radial cracking (NRC IN 92-57) have been observed in the shroud support access hole covers that are made from Alloy 600. Instances of cracking in core spray spargers have been reviewed in NRC Bulletin 80-13, and cracking in core spray pipe has been reviewed in BWRVIP-18. Cracking of the core plate has not been reported, but the creviced regions beneath the plate are difficult to inspect. BWRVIP-06R1-A and BWRVIP-25 address the safety significance and inspection requirements for the core plate assembly. Only inspection of core plate bolts (for plants without retaining wedges) or inspection of the retaining wedges is required. NRC IN 95-17 discusses cracking in top guides of United States and overseas BWRs. Related experience in other components is reviewed in NRC GL 94-03 and NUREG-1544. Cracking has also been observed in the top guide of a Swedish BWR. Instances of cracking have occurred in the jet pump assembly (NRC Bulletin 80-07), holddown beam (NRC IN 93-101), and jet pump riser pipe elbows (NRC IN 97-02). Cracking of dry tubes has been observed at 14 or more BWRs. The cracking is intergranular and has been observed in dry tubes without apparent sensitization, suggesting that IASCC may also play a role in the cracking. Two CRDM lead screw male couplings were fractured in a pressurized-water reactor (PWR), designed by Babcock and Wilcox (B&W), at Oconee Nuclear Station (ONS), Unit 3. The fracture was due to thermal embrittlement of 17-4 PH material (NRC IN 2007-02). While this occurred at a PWR, it also needs to be considered for BWRs. IGSCC in the X-750 materials of a tie rod coupling and jet pump hold-down beam was observed in a domestic plant. The program guidelines outlined in applicable and approved BWRVIP documents are based on an evaluation of available information, including BWR inspection data and information on the elements that cause SCC, IGSCC, or IASCC, to determine which components may be susceptible to cracking. Implementation of the program provides reasonable assurance that cracking will be adequately managed so the intended functions of the vessel internal components will be maintained consistent with the current licensing basis (CLB) for the period of extended operation.		
10.1: (NMP-1 plant visit) NMP-1 identified core shroud horizontal weld cracking following the BWRVIP-01 baseline inspection in 1995. The corrective action taken was to install a preemptive core shroud tie-rod repair, which followed the BWRVIP-02 shroud repair guidelines. In addition, core shroud vertical weld cracking was identified	The 2009 core shroud vertical inspection demonstrated that no new vertical weld cracking has occurred. The inspection, however, showed that the V9 and V10 weld cracks have continued to grow in depth and are effectively through wall. This condition is bounded by the design assumption used for the vertical weld clamps on V9 and	Revise Program Element 1 to include an assessment of the design

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
in 1997 following a baseline inspection required by BWRVIP-02 guidelines, and preemptive vertical weld clamps were installed in 1999.	V10. It is not clear whether the design basis analyses for the vertical weld clamps was updated during license renewal to ensure that they were consistent with the requirements of current Codes and Standards, and whether the effects of plant modifications on these analyses were addressed. In addition, if these clamps are made of X-750, industry OE indicates that IGSCC has been observed in X-750 materials (see comment 2.2 above).	basis analyses of the core shroud clamps.

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BWRVIP-14-A (EPRI 1016569), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2008.

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BWRVIP-18-A (EPRI 1011469), *BWR Vessel and Internals Project, BWR Core Spray Internals Inspection and Flaw Evaluation Guidelines,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, February 2005.

BWRVIP-19-A (EPRI 1012114), *BWR Vessel and Internals Project, Internal Core Spray Piping and Sparger Repair Design Criteria,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2005.

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A.10 XI.M10 Boric Acid Corrosion

The verbatim text of GALL, Rev. 2, AMP XI.M10, Boric Acid Corrosion, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to Ginna plant is identified in the table; all remaining line items are the result of a general review of the AMP by the ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
Program Description		
The program relies in part on implementation of recommendations in Nuclear Regulatory Commission (NRC) Generic Letter (GL) 88-05 to monitor the condition of the reactor coolant pressure boundary for borated water leakage. Periodic visual inspection of adjacent structures, components, and supports for evidence of leakage and corrosion is an element of the NRC GL 88-05 monitoring program. Potential improvements to boric acid corrosion programs have been identified because of recent operating experience with cracking of certain nickel alloy pressure boundary components (NRC Regulatory Issue Summary 2003-013). Borated water leakage from piping and components that are outside the scope of the program established in response to NRC GL 88-05 may affect structures and components that are subject to aging management review (AMR). Therefore, the scope of the monitoring and inspections of this program includes all components that contain borated water and that are in proximity to structures and components that are subject to AMR. The scope of the evaluations, assessments, and corrective actions include all observed leakage sources and the affected structures and components. Borated water leakage may be discovered through activities other than those established specifically to detect such leakage. Therefore, the program includes provisions for triggering evaluations and assessments when leakage is discovered by other activities. The effects of boric acid corrosion on reactor coolant pressure boundary materials in the vicinity of nickel alloy components are managed by GALL AMP XI.M11B, “Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-induced Corrosion in Reactor Coolant Pressure Boundary Components.”		
a.1: The program description of GALL Rev. 2 AMP XI.M10 does not include the objective of the.	The program description does not state that the AMP manages the aging effects of loss of material due to boric acid corrosion on the intended function of an affected structure and component by detection of borated water leakage. This is the most important component of the program description and should be clearly described in this section.	Revise the program description to include the objective of this AMP.
a.2: The program description states that the program includes provisions for triggering evaluations and assessments when leakage is discovered by other	The scope of the Boric Acid Corrosion program includes all carbon and low-alloy steel structures and components including electrical components in or near the reactor	Revise the program description to

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
activities. However, the program description further states that the GALL AMP XI.M11B manages the effects of boric acid corrosion on reactor coolant pressure boundary materials in the vicinity of nickel alloy components. As discussed in the review of GALL AMP XI.M11B, it is unclear why the management of loss of material due to boric acid corrosion (or wastage) caused by coolant leakage from cracks in nickel-alloy components is considered different and not covered under GALL AMP XI.M10, "Boric Acid Corrosion," which specifically deals with this issue.	coolant system, engineered safety features, or steam and power conversion systems. A large majority of these structures and components are likely to be affected by potential coolant leakage from cracking in nickel-alloy components or welds and, therefore, covered under the GALL AMP XI.M11B for "Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components." The GALL AMP XI.M11B does not include any guidance regarding engineering evaluations and corrective actions that need to be performed once leakage is discovered, to ensure that boric acid wastage does not lead to degradation of the leakage source or adjacent structures or components. Such guidance is provided in RG 1.45, and the relevant portions of this guidance could be incorporated into the updated GALL report. Instead of duplicating the GALL AMP XI.M10 guidance in GALL AMP XI.M11B, it would be prudent to delete the recommendation of managing boric acid wastages of some components under a different program such as XI.M11B.	include the proposed change.
Program Basis Documents and/or Supporting Documents		
The program consists of recommendations in NRC Generic Letter (GL) 88-05 to monitor the condition of the reactor coolant pressure boundary for borated water leakage to ensure that corrosion caused by leaking borated coolant does not lead to degradation of the leakage source or adjacent structures and components, and on the guidance of NRC Regulatory Issue Summary (RIS) 2003-013, which identifies potential improvements to the boric acid corrosion program based on recent operating experience with cracking of certain nickel alloy pressure boundary components.		
b.1: Although program description of the GALL AMP refers to the recommendations of GL 88-05 and the guidance of RIS 2003-013, it does not provide any details regarding the various activities of the program. For example, the GL 88-05 program for procedurally controlling wastage due to boric acid corrosion consists of the following activities:	Nearly all applicants have included a statement that its AMP is consistent with the recommendations of these documents, but do not provide any other details. For example, Attachment 1 to RIS 2003-013 identifies the following weaknesses in this AMP regarding the above four activities described in GL 88-05:	Revise program description to clearly identify significance of the basis

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
5. Determination of the principal locations where leaks smaller than the allowable technical specification limit can result in high concentrations of boric acid on the surfaces of pressure boundary components and cause boric acid corrosion. 6. Procedures for locating these small coolant leaks and establishing (a) the path of the leaking coolant and the reactor pressure boundary components it is likely to contact, and (b) interactions between the coolant and component materials. 7. Methods for conducting examinations and engineering evaluations to establish the impact of the leakage on the reactor pressure boundary components. 8. Corrective actions to prevent reoccurrences of such wastage, including any modifications in the design and operating procedures that (a) reduce the probability of coolant leaks at the locations where they may cause corrosion damage and (b) involve the use of corrosion resistant materials or application of coatings.	6. Many plants have not taken steps to identify locations that are susceptible to cracking. 7. Licensees are relying solely on visual examinations in the course of walkdowns during refueling outages to look for evidence of leakage (e.g., boric acid crystals or rust stains). It is not common to perform inspections such as bare metal visual (BMV) examinations that are capable of detecting leakage from through-wall cracks. (Note, however, that BMV examinations are provided for in ASME Code Section XI, Subsection IWA-5240.) Also, few plants perform BMV inspections in high-radiation areas (e.g., of the in-core instrumentation penetrations in the vessel lower head). In addition, detection of leakage during power operation relies on inventory balance calculations typically performed once a day, which are not adequate to detect “small” leaks. This latter weakness has been largely addressed by NRC Order EA-03-009 issued in 2003 (revised in 2004) requiring licensees for operating PWRs to conduct periodic bare metal visual inspections of 100% of the reactor pressure vessel head surface, as well as ultrasonic or eddy current inspections of the head penetration nozzle and J-groove weld regions. NRC RG 1.45 suggests several methods for leakage detection during power operation, but quantification of leak rates remains problematic. 8. The exact location or the magnitude of leaks may not be detected by looking for the presence of boric acid crystals on leaking components or nearby targets because boric acid leakage can become airborne and boric acid crystals can form in other locations such as containment ventilation filters. We recommend specific inclusion of these technical considerations for consistency in implementation if the specific guidance in these documents were clearly	and supporting documents.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
	identified in the program description.	
Program Consistency and Commitments		
The Boric Acid Corrosion program implemented by Ginna is consistent with GALL Rev. 0 AMP XI.M10 Boric Acid Corrosion program with the enhancement; it also manages boric acid wastage of components outside of the reactor coolant system (RCS), including cable connectors and cable trays as well as other susceptible systems and components. The Ginna AMP with the enhancement is consistent with the GALL Rev. 2		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
The program covers any structures or components on which boric acid corrosion may occur (e.g., steel, copper alloy >15% zinc, and aluminum) and electrical components onto which borated reactor water may leak. The program includes provisions in response to the recommendations of NRC GL 88-05. NRC GL 88-05 provides a program consisting of systematic measures to ensure that corrosion caused by leaking borated coolant does not lead to degradation of the leakage source or adjacent structures and components, and provides assurance that the reactor coolant pressure boundary will have an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. Such a program provides for (a) determination of the principal location of leakage, (b) examinations and procedures for locating small leaks, and (c) engineering evaluations and corrective actions to ensure that boric acid corrosion does not lead to degradation of the leakage source or adjacent structures or components, which could cause the loss of intended function of the structures or components.		
1.1: No significant concern or further review item was identified.		
2. Preventive Actions		
This program is a condition monitoring program; thus, there are no preventive actions. However, minimizing reactor coolant leakage by frequent monitoring of the locations where potential leakage could occur and timely repair if leakage is detected prevents or mitigates boric acid corrosion.		
2.1: This program element states that there are no preventive actions in this AMP. This statement is not correct. The aging management activities recommended in GL 88-05 include preventive measures such as "modifications in the design and operating procedures, which : (a) reduce the probability of coolant leaks at the locations where they may cause corrosion damage; and,	Slow leakage from a flange connection or through-wall cracks may leave deposits of boric acid crystals on top of reactor component surfaces. When heated, boric acid (H_3BO_3) decomposes at 170 °C into metaboric acid HBO_2, which is liquid above 236 °C, and further heating above 300 °C transforms to solid boron trioxide B_2O_3. It is known that dry boric acid deposits	Revise this program element to include the proposed preventive

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
(b) involve the use of corrosion resistant materials or application of coatings." Furthermore, timely removal of boric acid crystals and clean-up from top of reactor component materials that are susceptible to boric acid corrosion or wastage is a preventive measure, and its importance should be included in this program element. Also, note that program element 7 "Corrective Actions" states that these three preventive measures should be included in the program implementation to prevent recurrences of degradation caused by borated water leakage.	on hot surfaces are non-corrosive (NUREG/CR-6875). However, an introduction of moisture to these boric acid deposits from leaking flange connections or crack can lead to significant boric acid wastage. The heat of evaporation provides cooling, and if the rate at which moisture is added to the pile of deposits is equal to the rate at which moisture evaporates, a concentrated solution of boric acid will form under the pile of deposits. The solution temperature may be as high as 150 to 170 °C. The presence of such concentrated liquid boric acid is corrosive to reactor components. Therefore, modifications in the design, and operating procedures to reduce coolant leaks, use of corrosion resistant materials or protective coating, and timely removal of any boric acid deposits from susceptible reactor components are all measures that could prevent boric acid wastage.	action.
3. Parameters Monitored/Inspected		
The aging management program monitors the aging effects of loss of material due to boric acid corrosion on the intended function of an affected structure and component by detection of borated water leakage. Borated water leakage results in deposits of white boric acid crystals and the presence of moisture that can be observed by visual examination. Boric acid deposits, borated water leakage, or the presence of moisture that could lead to the identification of loss of material can be monitored through visual examination.		
3.1: (Ginna plant visit) Consistent with the guidance of NRC RIS 2003-013, the Ginna AMP includes the identification of reactor coolant system locations that contain nickel alloys or welds (e.g., control rod penetrations) for inspections. At Ginna, an initial inspection by a team of pipe fitting and decontamination staff, examines relevant surfaces when the system is "as hot as possible," to identify locations of interest. The second team, composed of a VT-2 qualified inspection (who has boric acid training per EPRI) and a trainee or support engineer, later implement follow-up activities.	The licensee stated that during leakage evaluations, any identified boric acid residue is evaluated to ensure it does not contain rust-like coloring. Also, when a leakage is identified within the containment or in an area with enclosed ventilation units, the ventilation units are evaluated for evidence of boric acid deposit. This activity of examining and evaluating the ventilation units for evidence of boric acid wastage residue is of particular importance in view of the operating experience at Davis Besse, and should be included in this program element.	Revise element 3 to include the proposed information.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
4. Detection of Aging Effects		
Degradation of the component due to boric acid corrosion cannot occur without leakage of borated water. Conditions leading to boric acid corrosion, such as crystal buildup and evidence of moisture, are readily detectable by visual inspection, though removal of insulation may be required in some cases. However, for leakage examinations of components with external insulation surfaces and joints under insulation or not visible for direct visual examination, the surrounding area (including the floor, equipment surfaces, and other areas where leakage may be channeled) is examined for evidence of component leakage. Discoloration, staining, boric acid residue, and other evidence of leakage on insulation surfaces and the surrounding area are given particular consideration as evidence of component leakage. If evidence of leakage is found, removal of insulation to determine the exact source may be required. The program delineated in NRC GL 88-05 includes guidelines for locating small leaks, conducting examinations, and performing engineering evaluations. In addition, the program includes appropriate interfaces with other site programs and activities, such that borated water leakage that is encountered by means other than the monitoring and trending established by this program is evaluated and corrected. Thus, the use of the NRC GL 88-05 program assures detection of leakage before the loss of the intended function of the affected components.		
4.1: (Ginna plant visit) The presence of rust-colored stains in the boric acid surface residue is an indicator of possible significant corrosion of the underlying ferritic material. This observation becomes especially important in light of the severe boric acid corrosion experienced in reactor vessel head at the Davis-Besse plant.	During the Ginna audit, plant personnel indicated that they specifically look for rust-colored stains in their visual examinations for boric acid deposits. It is noted that GALL XI.M10 program element 6 “Acceptance Criteria” does mention the detection of rust-colored deposits, but does not explain their possible significance. Future GALL revision should consider including a recommendation that any identified boric acid residue will be evaluated for the presence of rust-like stains.	Revise this program element to include the proposed information.
5. Monitoring and Trending		
The program provides monitoring and trending activities as delineated in NRC GL 88-05, timely evaluation of evidence of borated water leakage identified by other means, and timely detection of leakage by observing boric acid crystals during normal plant walkdowns and maintenance.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
Any detected borated water leakage, white or discolored crystal buildup, or rust-colored deposits are evaluated to confirm or restore the intended functions of affected structures and components consistent with the design basis prior to continued service.		
6.1: No significant concern or further review item was		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
identified.		
7. Corrective Actions		
The NRC finds that the requirements of 10 CFR Part 50, Appendix B, with additional consideration of the guidance in NRC GL 88-05, are acceptable to implement the corrective actions related to this program. Borated water leakage and areas of resulting boric acid corrosion are evaluated and corrected in accordance with the applicable provisions of NRC GL 88-05 and the corrective action program. Any detected boric acid crystal buildup or deposits should be cleaned. NRC GL 88-05 recommends that corrective actions to prevent recurrences of degradation caused by borated water leakage be included in the program implementation. These corrective actions include any modifications to be introduced in the present design or operating procedures of the plant that (a) reduce the probability of primary coolant leaks at locations where they may cause corrosion damage and (b) entail the use of suitable corrosion resistant materials or the application of protective coatings or claddings.		
7.1: (Ginna plant visit) In accordance with the guidance of GL 88-05, the GALL AMP recommends that corrective actions should be included in the program to prevent recurrences of degradation caused by borated water leakage, and that these corrective actions include any modifications in the present design or operating procedures of the plant that reduce the probability of primary coolant leaks at locations where they may cause corrosion damage.	The Ginna plant continues to find boric acid deposits during each refueling outage and conduct corrective actions The number of findings appears to be holding fairly steady. Also, although there were repetitive findings of boric acid deposits, there has been no indication of problems with repeat locations having boric acid deposits. To ensure compliance with the recommendations of GL 88-05, particularly for subsequent license renewal, future GALL revision may ask the applicants to prepare a list of observed primary coolant leakage where they may have caused boric acid wastage, and identify which of these were repetitive findings of coolant leakage and/or boric acid deposits.	Revise this program element to include the proposed information.
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action
this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Boric acid corrosion has been observed in nuclear power plants (NRC Information Notice [IN] 86-108 [and supplements 1 through 3] and NRC IN 2003-02) and has resulted in significant impairment of component-intended functions in areas that are difficult to access/observe (NRC Bulletin 2002-01).		
10.1: The present Operating Experience section in GALL, Rev. 2 consists of a single sentence that references NRC generic communications in which plant experience related to boric acid corrosion is described. No assessment of the relative severity and significance of these events is provided.	It would be more informative to expand the Operating Experience narrative to briefly describe the various types of boric acid corrosion that have been observed, their significance, and mitigation and prevention actions taken by a licensee.	Update this program element to include a brief description of various types of boric acid wastage processes.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Generic Letter 88-05, *Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants*, U.S. Nuclear Regulatory Commission, March 17, 1988.

NRC Information Notice 86-108, *Degradation of Reactor Coolant System Pressure Boundary Resulting from Boric Acid Corrosion*, U.S. Nuclear Regulatory Commission, December 26, 1986; Supplement 1, April 20, 1987; Supplement 2, November 19, 1987; and Supplement 3, January 5, 1995.

NRC Bulletin 2002-01, *Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity,* U.S. Nuclear Regulatory Commission, March 18, 2002.

NRC Bulletin 2002-02, *Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs,* U.S. Nuclear Regulatory Commission, August 9, 2002.NRC Information Notice 2002-11, *Recent Experience with Degradation of Reactor Pressure Vessel Head,* U.S. Nuclear Regulatory Commission, March 12, 2002.

NRC Information Notice 2002-13, *Possible Indicators of Ongoing Reactor Pressure Vessel Head Degradation,* U.S. Nuclear Regulatory Commission, April 4, 2002.

NRC Information Notice 2003-02, *Recent Experience with Reactor Coolant System Leakage and Boric Acid Corrosion,* U.S. Nuclear Regulatory Commission, January 16, 2003.

NRC Regulatory Issue Summary 2003-013, *NRC Review of Responses to Bulletin 2002-01, 'Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity,'* U.S. Nuclear Regulatory Commission, July 29, 2003.

NUREG-1823, *U.S. Plant Experience with Alloy 600 Cracking and Boric Acid Corrosion of Light- Water Reactor Pressure Vessel Materials*, U.S. Nuclear Regulatory Commission, April 2005.

A.11 XI.M11B Cracking of Nickel-Alloy Components and Loss of Material due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWR only)

The verbatim text of GALL, Rev. 2, AMP XI.M11B, Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWRs Only), is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to Ginna plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program replaces AMPs XI.M11, "Nickel-Alloy Nozzles and Penetrations" and XI.M11A, "Nickel-Alloy Penetration Nozzles Welded to the Upper Reactor Vessel Closure Heads of Pressurized Water Reactors." It addresses the issue of cracking of nickel-alloy components and loss of material due to boric acid-induced corrosion in susceptible, safety-related components in the vicinity of nickel-alloy reactor coolant pressure boundary components. A final rule (September 2008) updating 10 CFR 50.55a requires the following American Society of Mechanical Engineer (ASME) Boiler and Pressure Vessel (B&PV) Code Cases: (a) N-722, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials, Section XI, Division 1" to establish long-term inspection requirements for the pressurized water reactor (PWR) vessel, steam generator, pressurizer components and piping if they contain the primary water stress corrosion cracking (PWSCC) susceptible materials designated alloys 600/82/182; and (b) N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1" to establish new requirements for the long-term inspection of reactor pressure vessel upper heads. In addition, dissimilar metal welds need additional examinations to provide reasonable assurance of structural integrity. The U.S. Nuclear Regulatory Commission (NRC) issued Regulatory Information Summary (RIS) 2008-25, "Regulatory Approach for Primary Water Stress Corrosion Cracking (PWSCC) of Dissimilar Metal Butt Welds in Pressurized Water Reactor Primary Coolant System Piping" (October 2008) which stated the regulatory approach for addressing PWSCC of dissimilar metal butt welds. The RIS documents the NRC's approach to ensuring the integrity of primary coolant system piping containing dissimilar metal butt welds in PWRs and, in conjunction with the mandated inspections of ASME Code Case N-722, ensures that augmented in-service inspections (ISI) of all nickel-based alloy components and welds in the reactor coolant system (RCS) continue to perform their intended functions. As stated in this RIS, the NRC has found that MRP-139, "Primary System Piping Butt Weld Inspection and Evaluation Guideline" (2005), and MRP interim guidance letters provide adequate protection of public health and safety for addressing PWSCC in dissimilar metal butt welds pending the incorporation of ASME Code Case N-770, containing comprehensive inspection requirements, into 10 CFR 50.55a. It is		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
the intention of the NRC to replace MRP-139 by incorporating the requirements of ASME Code Case N-770 into 10 CFR 50.55a. The impacts of boric acid leakage from non-nickel alloy reactor coolant pressure boundary components are addressed in AMP XI.M10, "Boric Acid Corrosion." The Water Chemistry program for PWRs relies on monitoring and control of reactor water chemistry based on industry guidelines as described in AMP XI.M2, "Water Chemistry."		
a.1: The various documents listed in the description appear to address same components/locations or overlapping inspection requirements, without actually being clear as to the scope and purpose of each document. The reason for RIS 2008-25 additional requirements for dissimilar metal butt welds, to supplement N-722, is unclear. MRP-139, as basis for resolution in RIS 2008-25, is described above as adequate for addressing PWSCC in dissimilar butt welds – but it appears to need N-722 as well. NOTE: Currently there is an N-722-1 revision for the Code Case.	It should be stated that: (a) the Code Case N-722 does not address the reactor vessel closure head (even though it may contain Alloy 600/82/182 welds of the Class1 component) that is covered under Code Case N-729-1, (b) CC N-729-1 scope includes PWSCC resistant materials as well as PWSCC susceptible materials. If the MRP-139 (and N-770 when approved) requirements are needed in addition to the N-722, this and the reason they are necessary need to be stated. The current inspections required under the ASME Code, Section XI, do not address PWSCC degradation of Alloy 82/182 butt welds. The safety consequences of inadequate inspections can be significant.	Add clarification on the scope (limitations) and reasons for each basis document for the AMP.
a.2: It is unclear why the management of (loss of material from) boric acid leakage is different from, and not covered under, the XI.M10 AMP that specifically deals with this issue. The statement of fact that XI.M2 covers reactor water chemistry does not provide any purpose or linkage to the added inspection requirements that seem to be the main area of coverage under this XI.M11B AMP.	Either put the boric acid leakage management aspect under the XI.M10 AMP, or add clarification/reasons for it to be part of this AMP. If XI.M2 is a requisite supplemental AMP to manage the aging effects under this AMP, then this should be clearly stated, along with an explanation.	Add clarification for the connection to AMPs XI.M10 and XI.M2.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of its program description the basis documents: ASME Code Cases N-770 (when approved), N-722, and N-729-1, the EPRI MRP-139, and NRC RIS 2008-25. These are to supplement the ASME Section XI ISI requirements as incorporated in 10 CFR 50.55a.		
b.1: NOTE: Currently approval is being finalized for the N-	A clear statement as above would be helpful guidance.	Revise/updat

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
722-1 revision for the Code Case, and N-770-1 (replacing MRP-139).		e the program description.
Program Consistency and Commitments		
The LRA and SER for Ginna note that the AMP as reviewed was consistent with the GALL, Rev. 0, AMP.		
c.1: (Ginna plant visit) This AMP and associated OE have changed significantly since GALL, Rev. 0. The program at Ginna does note that it is actively updated following industry guidance.	This is an important AMP for the pressure boundary components covered for the PWSCC, and confirmation of the proper, timely updating of program requirements needs to be documented.	Review/revise documentation requirements.
1. Scope of Program		
The program is focused on managing the effects of cracking due to PWSCC of all susceptible nickel alloy-based components of the reactor coolant pressure boundary (including nickel-alloy welds). The program also manages the loss of material due to boric acid corrosion in susceptible components in the vicinity of nickel-alloy components. These components could include, but are not limited to, the reactor vessel components (reactor pressure vessel upper head), steam generator components (nozzle-to-pipe connections, instrument connections, and drain tube penetrations), pressurizer components (nozzle-to-pipe connections, instrument connections, and heater penetrations), and reactor coolant system piping (instrument connections and full penetration welds).		
1.1: The requirements of Code Case N-729-1 include Ni-base alloys believed to be resistant to PWSCC. It also includes the welds associated with all nickel alloy components exposed to the primary water.	Include updated basis documents.	Revise the scope statement.
2. Preventive Actions		
This program is a condition monitoring program and does not include preventive or mitigative measures. However, maintaining high water purity reduces susceptibility to PWSCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry program. The program description and the evaluation and technical basis of monitoring and maintaining reactor water chemistry are presented in GALL AMP XI.M2, "Water Chemistry." At the discretion of the applicant, preventive actions to mitigate PWSCC may be addressed by various measures (e.g., weld overlays, replacement of components with more PWSCC-resistant materials, etc.).		
2.1: Use of PWSCC-resistant nickel-based alloys may not	Any preventive action, if credited to reduce the	Revise the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
provide an absolute guarantee of its non-occurrence over the period of extended operation.	inspection requirements under this AMP, without OE, should require an adequate justification and review with Staff's approval.	Actions element.
3. Parameters Monitored/Inspected		
This is a condition monitoring program that monitors cracking/PWSCC for nickel-alloy components and loss of material by boric acid corrosion for potentially affected steel component. Reactor coolant pressure boundary cracking and leakage are monitored by the applicant's in-service inspection program in accordance with 10 CFR 50.55a and industry guidelines (e.g., MRP-139). Boric acid deposits, borated water leakage, or the presence of moisture that could lead to the identification of cracking or loss of material can be monitored through visual examination.		
3.1: Although this AMP is for aging effect of SCC under primary water, any identified off-normal chemistry events may confound the implementation and consequences of this AMP.	The AMP does refer to Water Chemistry AMP – but identification and assessment of any off-normal chemistry should be included as part of this program element.	Revise text with guidance on chemistry.
4. Detection of Aging Effects		
The program detects the effect of aging by various methods, including non-destructive examination techniques. Reactor coolant pressure boundary leakage can be monitored through the use of radiation air monitoring and other general area radiation monitoring, and technical specifications for reactor coolant pressure boundary leakage. The specific types of non-destructive examinations are dependent on the component's susceptibility to PWSCC and its accessibility to inspection. Inspection methods, schedules, and frequencies for the susceptible components are implemented in accordance with 10 CFR 50.55a and industry guidelines (e.g., MRP-139).		
4.1: No significant concern or further review item was identified.	Include updated basis documents for the detection requirements.	Add text.
5. Monitoring and Trending		
Reactor coolant pressure boundary leakage is calculated and trended on a routine basis in accordance with technical specification to detect changes in the leakage rates. Flaw evaluation through 10 CFR 50.55a is a means to monitor cracking.		
5.1: It is unclear what flaw evaluation in 10 CFR 50.55a is being credited and how, for monitoring purposes.	Include clarification.	Clarify or revise the element.
5.2: While the plant Technical Specifications will be the basis for action in response to the results of monitoring and	Appropriate guidance in using the results of this program element may be of value to improve the effectiveness of	Revise text and add

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
trending activity, it is not clear how this activity interfaces with and/or improves the AMP.	this AMP by identifying precursors.	guidance.
6. Acceptance Criteria		
Acceptance criteria for all indications of cracking and loss of material due to boric acid-induced corrosion are defined in 10 CFR 50.55a and industry guidelines (e.g., MRP-139).		
6.1: No significant concern or further review item was identified.	Include updated basis documents.	Update.
7. Corrective Actions		
Relevant flaw indications of susceptible components within the scope of this program found to be unacceptable for further services are corrected through implementation of appropriate repair or replacement as dictated by 10 CFR 50.55a and industry guidelines (e.g., MRP-139). In addition, detection of leakage or evidence of cracking in susceptible components within the scope of this program require scope expansion of current inspection and increased inspection frequencies of some components, as required by 10 CFR 50.55a and industry guidelines (e.g., MRP-139). Repair and replacement procedures and activities must either comply with ASME Section XI, as incorporated in 10 CFR 50.55a or conform to applicable ASME Code Cases that have been endorsed in 10 CFR 50.55a by referencing the latest version of NRC Regulatory Guide 1.147. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.	Include updated basis documents.	Update.
8. Confirmation Process		
Site quality assurance procedures and review and approval processes are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address confirmation process.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
This new program addresses reviews of related operating experience, including plant-specific information, generic industry findings, and international data. Within the current regulatory requirements, as necessary, the applicant maintains a record of operating experience through the required update of the facility's inservice inspection program in accordance with 10 CFR 50.55a. Additionally, the applicant follows mandated industry guidelines developed to address operating experience in accordance with NEI-03-08, "Guideline for the Management of Materials Issues." Cracking of Alloy 600 has occurred in domestic and foreign PWRs (NRC Information Notice [IN] 90-10). Furthermore, ingress of demineralizer resins also has occurred in operating plants (NRC IN 96-11). The Water Chemistry program, AMP XI.M2, manages the effects of such excursions through monitoring and control of primary water chemistry. NRC GL 97-01 is effective in managing the effect of PWSCC. PWSCC also is occurring in the vessel head penetration (VHP) nozzle of U.S. PWRs as described in NRC Bulletins 2001-01, 2002-01 and 2002-02.		
10.1: The operating experience of main interest involving the hot-leg cracking (at V.C. Summer), closure head CRDM weld cracking leading to boric acid corrosion (at Davis-Besse), and bottom head instrument nozzles (as in STP), does not seem related to any off-normal water chemistry.	The aging effect of main interest to this AMP is that of cracking under normally maintained primary water chemistry; it deals with the known and inherent susceptibility, especially over longer terms of operation, of nickel-based alloys to PWSCC.	This element needs updating with main issues and a summary (with review documents) of OE since 2001.
10.2: (Ginna plant visit) Based on the audit at Ginna, it is noteworthy that the licensee (RGE) has plans to implement the latest revisions of the Code Cases (not in GALL, Rev. 2) and that it is tracking the performance of PWSCC-resistant materials of type Alloy 690 and its welds.	Updating the AMP with the latest industry experience and guidelines is critical to managing the long-term aging effects of PWSCC.	Restate the importance of OE-based updating.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR Part 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Code Case N-722, *Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials*, July 5, 2005.

ASME Code Case N-729-1, *Alternative Examination Requirements for PWR Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds*, March 28, 2006.

ASME Code Case N-770, *Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities*, January 26, 2009.

MRP-139, Revision 1, *Primary System Piping Butt Weld Inspection and Evaluation Guideline*, Materials Reliability Program, December 16, 2008.

NEI-03-08, *Guideline for the Management of Materials Issues*, Nuclear Energy Institute, May 2003.

NRC Bulletin 2001-01, *Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles*, U.S. Nuclear Regulatory Commission, August 3, 2001.

NRC Bulletin 2002-01, *Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity*, U.S. Nuclear Regulatory Commission, March 18, 2002.

NRC Bulletin 2002-02, *Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs*, U.S. Nuclear Regulatory Commission, August 9, 2002.

NRC Generic Letter 97-01, *Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations*, U.S. Nuclear Regulatory Commission, April 1, 1997.

NRC Information Notice 90-10, *Primary Water Stress Corrosion Cracking (PWSCC) of Inconel 600*, U.S. Nuclear Regulatory Commission, February 23, 1990.

NRC Information Notice 96-11, *Ingress of Demineralizer Resins Increases Potential for Stress Corrosion Cracking of Control Rod Drive Mechanism Penetrations*, U.S. Nuclear Regulatory Commission, February 14, 1996.

NRC Inspection Manual, *Inspection Procedure 71111.08, Inservice Inspection Activities*, March 23, 2009.

NRC Inspection Manual, *Temporary Instruction 2515/172, Reactor Coolant System Dissimilar Metal Butt Welds*, February 21, 2008.

NRC Regulatory Guide 1.147, Revision 15, *Inservice Inspection Code Case Acceptability*, ASME Section XI, Division 1, U.S. Nuclear Regulatory Commission, January 2004.

NRC Regulatory Information Summary 2008-25, *Regulatory Approach for Primary Water Stress Corrosion Cracking of Dissimilar Metal Butt Welds in Pressurized Water Reactor Primary Coolant System Piping*, U.S. Nuclear Regulatory Commission, October 22, 2008.

NUREG-1823, *U.S. Plant Experience with Alloy 600 Cracking and Boric Acid Corrosion of Light- Water Reactor Pressure Vessel Materials*, U.S. Nuclear Regulatory Commission, April 2005.

A.12 XI.M12 Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)

The verbatim text of GALL, Rev. 2, AMP XI.M12, Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS), is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The reactor coolant system components are inspected in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI. This inspection is augmented to detect the effects of loss of fracture toughness due to thermal aging embrittlement of cast austenitic stainless steel (CASS) piping components except for pump casings and valve bodies. This aging management program (AMP) includes determination of the susceptibility of CASS components to thermal aging embrittlement based on casting method, molybdenum (Mo) content, and percent ferrite. For "potentially susceptible" components, as defined below, aging management is accomplished through either (a) qualified visual inspections, such as enhanced visual examination (EVT-1); (b) a qualified ultrasonic testing (UT) methodology; or (c) a component-specific flaw tolerance evaluation in accordance with the ASME Code, Section XI, 2004 edition.[10] Additional inspection or evaluations to demonstrate that the material has adequate fracture toughness are not required for components that are not susceptible to thermal aging embrittlement. For pump casings and valve bodies, based on the results of the assessment documented in the letter dated May 19, 2000, from Christopher Grimes, Nuclear Regulatory Commission (NRC), to Douglas Walters, Nuclear Energy Institute (NEI) (May 19, 2000 NRC letter), screening for susceptibility to thermal aging embrittlement is not required. The existing ASME Code Section XI inspection requirements, including the alternative requirements of ASME Code Case N-481 for pump casings, are adequate for all pump casings and valve bodies. Aging management of CASS reactor internal components of pressurized water reactors (PWRs) are discussed in AMP XI.M16A and of CASS reactor internal components of boiling water reactors (BWRs) in AMP XI.M9.		
a.1: (Ginna plant visit) Consistent with the GALL AMP, Ginna has followed option (c) of the GALL AMP and performed a plant-specific flaw tolerance evaluation to demonstrate that adequate fracture toughness exists for the RCS loop, including the elbows, for LTO. The results are documented in WCAP-15837 "Technical Justification for Eliminating Large Primary Loop Pipe Rupture as the	There are two issues not adequately addressed in the LRA: (1) The LRA and the response to RAI F-RAI B2.1.34-1 do not provide any details regarding the flaw tolerance evaluation. For example, it is not clear whether all CASS components had less than 25% ferrite, and whether the applicant followed the flaw tolerance methodology	Revise or update program description to include an evaluation of all

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Structural Design Basis for the R.E. Ginna Nuclear Power Plant for the License Renewal Program," April 2002. A separate evaluation was performed for the RCP casings in WCAP-15873 to qualify the pump casings to item (d) of the ASME Code Case N-481.	recommended in "Acceptance Criteria" section of the GALL AMP. Note that the GALL methodology is applicable only for CASS materials with less than 25% ferrite. Figure C-4 of EPRI report 1019128, "Nondestructive Evaluation: Flaw Tolerance Evaluation of Thermally Aged Cast Austenitic Stainless Steel Piping," Dec. 2009, shows a plot of the distribution of the ferrite contents in CF-8M CASS material from random sampling of heats of CASS material from 15 plants supplied from two vendors between 1969 and 1976, a few other sources of data. The plot indicates that at least 8% of the heats have greater than 25% ferrite. The plants that have CF-8M piping include Kewaunee, Prairie Island 2, Cook 1&2, Beaver Valley 1, and Sequoyah 1&2. Since the guidance in the GALL AMP is not applicable for such CASS materials, it is important to ask the applicants to list all the heats of CASS materials used in its plants, their composition, and their ferrite content. (2) The applicant did not clarify whether the flaw tolerance evaluations were updated in 2005 during Ginna EPU to incorporate the 16.8% increase in thermal power from 1520 to 1775 MWt. The flaw tolerance evaluations should account for any EPU greater than 5%. Even though the actual loadings or transients after EPU are below the design loads, the change in loadings due to EPU is likely to erode the design margins. To maintain proper records of plant loading history, such changes in actual loadings and/or in design margins due to EPU should be evaluated and adequately documented. Any change in the original design margins should be documented and is important for subsequent license renewal.	modification to plant design and operation that may affect the design bases loadings. This information should be collected during future plant visits.
Program Basis Documents and/or Supporting Documents		
The following documents provide the basis for this AMP or additional guidance for the AMP: (a) The AMP is based on the guidance in letter dated May 19, 2000, from Christopher Grimes, NRC, to Douglas Walters, NEI, and research data		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
presented in NUREG/CR-4513, Rev. 1, "Estimation of Fracture Toughness of Cast Stainless Steels during Thermal Aging in LWR Systems." (b) For inspection of CASS pump casings, in addition to the ASME Section XI requirements it includes the alternative requirements of ASME Code Case N-481 for pump casings. (c) For aging management of reactor core internal CASS components exposed to significant neutron irradiation, the GALL, Rev. 2, AMP XI.M12 recommends the guidance in GALL AMP XI.M16A for PWRs and XI.M9 for BWRs. (d) Since the current UT methodology is not reliable for detecting and sizing cracks in CASS components, an enhanced EVT-1 is recommended; the description of EVT-1 is found in BWRVIP-03, Rev. 6, for BWRs and MRP-228 for PWRs.		
b.1: Although program description of the GALL AMP refers to these documents, the significance of the documents is not obvious. For example, in GALL, Rev. 2, option (c) of this AMP states that aging management is accomplished through "a component-specific flaw tolerance evaluation in accordance with the ASME Code, Section XI, 2004 edition," whereas Rev. 1 stated simply a "plant- or component-specific flaw tolerance evaluation."	The revised version of the program seems to suggest that a flaw tolerance evaluation in accordance with 2004 edition of the ASME Code is acceptable. However, the current Code requirements do not account for the effects of thermal aging degradation of fracture toughness of CASS materials. This program was developed by the NRC to provide guidance for such evaluations, and industry has also accepted the GALL methodology. However, the limitation of this methodology, that it is not applicable for CASS materials with greater than 25% ferrite or for materials with high Nb content, seems not to have addressed in the review of LRAs.	Clearly identify the significance of basis and supporting documents. For future LRA reviews, verification of ferrite contents of CASS materials should be documented.
Program Consistency and Commitments		
The Ginna LRA states that its AMP for thermal aging embrittlement of CASS components is consistent with the GALL, Rev. 0, AMP XI.M12, and that the GALL AMP for reactor core internal CASS components is not applicable for NMP-1 because no CASS components that serve a license renewal intended function have been identified. The NMP-1 LRA states that the GALL XI.M12 AMP is not applicable because the inspection requirements for the ASME Section XI ISI are adequate for all potentially susceptible CASS components. In addition, the GALL XI.M13 AMP is not applicable because potentially susceptible components at NMP-1 are evaluated and inspected as part of the BWRVIP program.		
c.1: (Ginna & NMP-1 plant visits) Both LRAs have concluded that the inspection requirements for the ASME Section XI ISI are adequate for all potentially susceptible CASS components, and while the NMP-1 LRA does not	Several LRAs have referenced these two WCAP reports to demonstrate that CASS materials have acceptable fracture toughness even in the completely embrittled condition. The staff should review these documents to verify that these	Review the subject documents and update

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
provide any basis for this conclusion, Ginna refers to WCAP-15837 and WCAP-15873 for evaluations for piping and pump casing, respectively.	evaluations were performed in accordance with the guidance of the GALL AMP.	the program description accordingly.
1. Scope of Program		
This program manages loss of fracture toughness in potentially susceptible ASME Code Class 1 piping components made from CASS. The program includes screening criteria to determine which CASS components are potentially susceptible to thermal aging embrittlement and require augmented inspection. The screening criteria are applicable to all primary pressure boundary components constructed from cast austenitic stainless steel with service conditions above 250˚C (482˚F). The screening criteria for susceptibility to thermal aging embrittlement are not applicable to niobium-containing steels; such steels require evaluation on a case-by-case basis. Based on the criteria set forth in the May 19, 2000, NRC letter, the susceptibility to thermal aging embrittlement of CASS materials is determined in terms of casting method, molybdenum content, and ferrite content. For low-molybdenum content steels (SA-351 Grades CF3, CF3A, CF8, CF8A or other steels with ≤ 0.5 weight percent [wt.%] Mo), only static-cast steels with >20% ferrite are potentially susceptible to thermal embrittlement. Static-cast low-molybdenum steels with ≤20% ferrite and all centrifugal-cast low molybdenum steels are not susceptible. For high-molybdenum content steels (SA-351 Grades CF3M, CF3MA, and CF8M or other steels with 2.0 to 3.0 wt.% Mo), static-cast steels with >14% ferrite and centrifugal-cast steels with >20% ferrite are potentially susceptible to thermal embrittlement. Static-cast high-molybdenum steels with ≤14% ferrite and centrifugal-cast high-molybdenum steels with ≤20% ferrite are not susceptible. In the susceptibility screening method, ferrite content is calculated by using the Hull's equivalent factors (described in NUREG/CR-4513, Rev. 1) or a staff-approved method for calculating delta ferrite in CASS materials. A fracture toughness value of 255 kilojoules per square meter (kJ/m^2) (1,450 inches-pounds per square inch) at a crack depth of 2.5 millimeters (0.1 inch) is used to differentiate between CASS materials that are not susceptible and those that are potentially susceptible to thermal aging embrittlement. Extensive research data indicate that for CASS materials not susceptible to thermal aging embrittlement, the saturated lower-bound fracture toughness is greater than 255 kJ/m^2 (NUREG/CR-4513, Rev. 1). For pump casings and valve bodies, screening for susceptibility to thermal aging embrittlement is not needed (and thus there are no aging management review line items). For all pump casings and valve bodies greater than a nominal pipe size (NPS) of 4 inches, the existing ASME Code, Section XI inspection requirements, including the alternative requirements of ASME Code Case N-481 for pump casings, are adequate. ASME Code, Section XI, Subsection IWB requires only surface examination of valve bodies less than a NPS of 4 inches. For these valve bodies less than a NPS of 4 inches, the adequacy of inservice inspection (ISI) according to ASME Code, Section XI has been demonstrated by an NRC-performed bounding integrity analysis (May 19, 2000 letter).		
1.1: The scope of program states, "the screening criteria for susceptibility to thermal aging embrittlement are not applicable to niobium-containing steels; such steels require evaluation on a case-by-case basis." The staff should note	This is a key condition that should be used by the applicant to check whether or not the GALL AMP, and its screening criteria, is applicable for the CASS components in its plant. To confirm the applicability of GALL AMP XI.M12, the	Revise or update element 1 of the AMP to

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
that this statement does not mean Nb-bearing CASS materials (e.g., CF8C) but CF3, CF8, or CF8M grades of CASS that contain ≥0.2 wt.% Nb.	applicant should be requested to provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content, and whether or not the cast materials contain ≥0.2 wt.% Nb. This list should be either included in the LRA or in supporting documents made available to NRC reviewers during plant audit.	clarify GALL AMP guidance.
1.2: (Ginna plant visit) For valve bodies and pump casings, the Ginna program specifies demonstration of compliance with the requirements of Code Case N-481 as the primary aging management approach, with supplemental visual inspections; if this approach fails, ASME Section XI volumetric ISI is specified as the alternative. This program is consistent with the GALL, Rev. 0, recommendations, which specified ISI in accordance with 1995 edition of ASME Section XI Table IWB-2500-1 Examination Category B-L-1 or B-M-1. Item No. B12.10 for pump casing welds and B12.40 for valve body welds (>NPS 4) required volumetric examination. The alternative to pump casing welds was CC N-481 guidelines, which included VT-2 visual of the external surface of all pump casing during pressure testing, VT-1 visual of the external surfaces of the weld of one pump casing, VT-3 visual of the internal surfaces of a pump when it is disassembled, and to demonstrate the safety and serviceability of the pump casing, a flaw tolerance evaluation in accordance with N-481(d), considering thermal aging embrittlement and other processes that may degrade the properties of the pump casing. For the pump casing welds, in GALL, Rev. 1, the Code edition was changed to 2001 (Rev. 2 refers to 2004), which requires only surface examination and CC N-481 has been deleted.	The language in GALL, Rev. 1, is confusing. If the ASME Code requires only surface examination of pump casing welds then why do we need to follow CC N-481, which includes a flaw tolerance evaluation in addition to surface examination? In addition, it is well known that for CASS materials and welds, surface examination is not adequate, and even volumetric examination is inadequate for detecting flaws <30% through walls in CASS materials. It is not clear why the inspection of CASS pump casings has been relaxed in Rev. 1 and 2 of the Gall report. The technical basis that demonstrates that only surface examination without flaw tolerance analysis is acceptable is not available, or has not been documented by the licensee. Clarification is necessary regarding this change in the Code inspection requirements. Since the 2001 and later editions of the Code only require surface examination, and Code Case N-481 has been withdrawn, the GALL program should continue to follow the original recommendation and include a flaw tolerance evaluation in addition to surface examination.	Revise or update element 1 of the AMP to clarify GALL AMP guidance.
1.3: The Code Case N-481 discussed above provides	The description of the flaw tolerance evaluation in	Revise or

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
alternative requirements in lieu of the volumetric examinations specified in Table IWB-2500-1, Examination Category B-L-1, Item 12.10, for pump casing welds. In addition to visual examinations of internal and external surfaces of the pump casing, it includes a flaw tolerance evaluation to demonstrate the safety and serviceability of the pump casing. The effects of thermal aging embrittlement and other processes on the mechanical properties of the pump casing are to be considered in the evaluation.	accordance with N-481(d) is confusing. The alternative to visual or volumetric examination of the "pump casing weld" is a flaw tolerance evaluation based on the fracture mechanics properties of thermally aged pump casing material. Typically, the lower-bound saturation fracture toughness of the thermally embrittled pump casing CASS material is used in these N-481 analyses. Extensive research data indicate that this lower-bound toughness of CASS materials with up to 25% ferrite is similar to that for submerged arc or shielded metal arc welds with up to 20% ferrite. However, the fracture toughness of thermally aged weld, and not the CASS material, may represent the true lower-bound toughness for the pump casing. Clarification is necessary regarding whether the flaw tolerance evaluations should be performed using the fracture toughness of the thermally aged weld.	update element 1 of the AMP to clarify GALL AMP guidance.
2. Preventive Actions		
This program does not include preventive measures to mitigate thermal aging embrittlement.		
Not applicable.		
3. Parameters Monitored/Inspected		
The program monitors the effects of loss of fracture toughness on the intended function of the component by identifying the CASS materials that are susceptible to thermal aging embrittlement. The program does not directly monitor for loss of fracture toughness that is induced by thermal aging; instead, the impact of loss of fracture toughness on component integrity is indirectly managed by using visual or volumetric examination techniques to monitor for cracking in the components.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
For pump casings, valve bodies, and other "not susceptible" CASS piping components, no additional inspection or evaluations are needed		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
to demonstrate that the material has adequate fracture toughness. For "potentially susceptible" piping components, the AMP provides for qualified inspections of the base metal, such as enhanced visual examination (EVT-1) or a qualified UT methodology, with the scope of the inspection covering the portions determined to be limiting from the standpoint of applied stress, operating time, and environmental considerations. Examination methods that meet the criteria of the ASME Code, Section XI, Appendix VIII are acceptable. Alternatively, a plant-specific or component-specific flaw tolerance evaluation, using specific geometry, stress information, material properties, and ASME Code, Section XI can be used to demonstrate that the thermally-embrittled material has adequate toughness. Current UT methodology cannot detect and size cracks; thus, EVT-1 is used until qualified UT methodology for CASS can be established. A description of EVT-1 is found in Boiling Water Reactor Vessel and Internals Project (BWRVIP)-03 (Revision 6) and Materials Reliability Program (MRP)-228 for PWRs.		
4.1: No further review item was identified.		
5. Monitoring and Trending		
Inspection schedules in accordance with ASME Code, Section XI, IWB-2400 or IWC-2400, reliable examination methods, and qualified inspection personnel provide timely and reliable detection of cracks. If flaws are detected, the period of acceptability is determined from analysis of the flaw, depending on the crack growth rate and mechanism.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Flaws detected in CASS components are evaluated in accordance with the applicable procedures of ASME Code, Section XI, IWB-3500 or ASME Code, Section XI, IWC-3500. Flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with ASME Code, Section XI, IWB-3640 procedures for SAWs, disregarding the ASME Code restriction of 20% ferrite. Extensive research data indicates that the lower-bound fracture toughness of thermally aged CASS materials with up to 25% ferrite is similar to that for SAWs with up to 20% ferrite (Lee et al., 1997). Flaw tolerance evaluation for piping with >25% ferrite is performed on a case-by-case basis by using the applicant's fracture toughness data.		
6.1: Program element 6 Acceptance Criteria states, "Flaw tolerance evaluation for piping with >25% ferrite is performed on a case-by-case basis by using the applicant's fracture toughness data." Yet very few LRAs have provided a clear statement regarding whether heats of CASS with greater than 25% ferrite are used in their plants.	The license renewal applicant should check whether or not the GALL AMP is applicable for the CASS components in the applicant's plant. To confirm applicability of GALL AMP XI.M12, the applicant should be asked to provide a list of all CASS components and their grade, casting process, chemical composition, and ferrite content. This list should be either included in the LRA or in supporting documents made available to NRC reviewers during plant audit.	Revise or update element 6 of the AMP to clarify GALL AMP guidance.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
6.2: The XI.M12 AMP recommends either a qualified visual EVT-1 or UT examination to detect cracks, or a plant-specific or component-specific flaw tolerance examination to demonstrate that the thermally embrittled material has adequate fracture toughness.	In the flaw tolerance evaluation, the allowable flaw size is typically based on the lower-bound saturation fracture toughness of the thermally embrittled pump casing CASS material. Extensive research data indicate that this lower-bound toughness of CASS materials with up to 25% ferrite is similar to that for submerged arc or shielded metal arc welds with up to 20% ferrite. However, the saturation fracture toughness of thermally embrittled CASS material may not be the lower bound for the pump casing. The fracture toughness of thermally aged weld will be lower than that for the thermally aged CASS material. Clarification is necessary regarding whether the flaw tolerance evaluations should be performed using the fracture toughness of the thermally aged weld.	Revise or update element 6 of the AMP to clarify GALL AMP guidance.
7. Corrective Actions		
Repair and replacement are performed in accordance with ASME Code Section XI, IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
10. Operating Experience		
The AMP was developed by using research data obtained on both laboratory-aged and service-aged materials. Based on this information, the effects of thermal aging embrittlement on the intended function of CASS components will be effectively managed.		
10.1: No significant concern or further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

ASME Code Case N-481, *Alternative Examination Requirements for Cast Austenitic Pump Casings*, Section XI, Division 1.

BWRVIP-03, Rev. 6, *BWR Vessel and Internals Project: Reactor Pressure Vessel and Internals Examination Guidelines* (EPRI TR-105696).

Lee, S., Kuo, P. T., Wichman, K., and Chopra, O., *Flaw Evaluation of Thermally-Aged Cast Stainless Steel in Light-Water Reactor Applications*, Int. J. Pres. Vessel and Piping, pp 37- 44, 1997.

NRC Letter from Christopher I. Grimes, U.S. Nuclear Regulatory Commission, License Renewal and Standardization Branch, to Douglas J. Walters, Nuclear Energy Institute, License Renewal Issue No. 98-0030, *Thermal Aging Embrittlement of Cast Stainless Steel Components*, May 19, 2000. (ADAMS Accession No. ML003717179)

Letter from Mark J. Maxin, to Rick Libra (BWRVIP Chairman), Safety Evaluation for Electric Power Research Institute (EPRI) Boiling Water Reactor Vessel and Internals project (BWRVIP) Report TR-105696-R6 (BWRVIP-03), Revision 6, BWR Vessel and Internals Examination Guidelines (TAC No MC2293)," June 30, 2008 (ADAMS Accession No ML081500814)

MRP-228, *Materials Reliability Program: Inspection Standard for PWR Internals,* 2009.

NUREG/CR-4513, Rev. 1, *Estimation of Fracture Toughness of Cast Stainless Steels During Thermal Aging in LWR Systems*, U.S. Nuclear Regulatory Commission, August 1994.

A.13 XI.M14 Loose Part Monitoring

The program description and description of the 10 program elements of GALL, Rev. 1, AMP XI.M14, Loose Part Monitoring, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on the visit to the Ginna plant (since AMP not reviewed at NMP-1) is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program relies on an inservice monitoring program to detect and monitor loose parts in light-water reactor (LWR) power plants. This in-service loose part monitoring (LPM) program is based on the recommendations from the American Society of Mechanical Engineers operation and maintenance standards and guides (ASME OM-S/G)-1997, Part 12, "Loose Part Monitoring in Light-Water Reactor Power Plants."		
a.1: As stated in NUREG-1950 (basis document for GALL, Rev. 2) the AMP XI.M14 was eliminated due to lack of relevance and very limited previous usage in submitted LRAs.	In the absence of a well-supported and documented basis for elimination of this program, the underlying loose part related degradation during the PEO, especially the on-line monitoring aspect, is being managed through the presumed total absence of significant loose parts in the entire reactor coolant system.	Document an assessment of the reasons for eliminating this program and its relevance for the PEO.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 1, AMP includes as part of its program description the basis document to be ASME OM-S/G-1997, Part 12.		
b.1: The EPRI NP-5743 (March 1988) report provided comprehensive guidelines to the nuclear industry for establishing or improving LPMS, and the RG 1.133 (1981) required reactors licensed since 1978 to include systems to detect parts and components that have become loose within reactor vessels and primary coolant systems.	The basis and recommendations from these additional documents, although dated earlier than the ASME OM-S/G, are relevant to the program objectives.	Update the program description to include these documents.

[1] Proposed action for NRC to consider for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Consistency and Commitments		
The SER for Ginna did not review this AMP. As such, no related consistency review or commitments for the PEO were applicable to Ginna.		
c.1: There is no requirement for implementing this AMP, per Rev. 2 of the GALL report.	Re-assessment of online loose part monitoring (LPM) seems relevant for the PEO.	Review LPM requirements.
1. Scope of Program		
The program includes measures to monitor and detect metallic loose parts by using transient signals analysis on acoustic data generated due to loose parts impact. The program is applicable, but not necessarily limited to, the reactor vessel and primary coolant systems in pressurized water reactors (PWRs) and the reactor recirculation system in boiling water reactors (BWRs). The detection and monitoring system includes a set of accelerometers installed in the vicinity of regions where loose parts impact is likely to occur. The system incorporates the capability of automatic annunciation (audible and visual), audio monitoring, automatic and manual signal recording, and acoustic signal analysis/evaluation. Measures for personnel radiation exposure and safety are included as part of the requirements of the LPM system. The objective of the LPM program is to provide early indication of component degradation.		
1.1: The primary intent of this original AMP on LPM was to provide early indication of component degradation while the plant is in (normal) operation. The monitoring (and detection) program deals with the flow-induced vibrations leading to wear (loss of material) and/or fretting as the primary aging degradation, with LPM that includes the reactor coolant system in general. The resulting degradation of concern addressed by LPM, in contrast to other related inspections/AMPs, can be system-wide (i.e., unfocused or unspecified areas are generally covered by LPM), which is significant since the damage due to loose parts or flow pattern distortions is not limited, a priori, to any specific or known location. In addition, the monitoring is typically online and takes place in real time. These aspects of aging degradation are otherwise not addressed if LPM (or similar) programs are not included in the AMP structure.	The unspecified nature/location of the damage, as intended to be covered by the original AMP, also means that safety significance (of degradation) cannot be ruled out, a priori, without assurance that there will be no unidentified loose parts remaining—either due to maintenance or operational activities—that would degrade the functionality of any safety related system(s) prior to identification and timely correction.	Reconsider an appropriately scoped AMP for the LPM, incorporating better/reliable techniques of online monitoring as they are developed.
2. Preventive Actions		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The aging management program (AMP) is a monitoring/detection program that provides early indication and detection of the onset of aging degradation. It does not rely on preventive actions.		
2.1: Since this is not a preventive AMP, there is no assurance, as discussed above in item 1.1, that loose parts damage in unspecified manner and location has been eliminated.	Monitoring and early detection of loose part related damage during the PEO may need to be reconsidered, or at least addressed adequately by other AMPs or plant-specific actions.	Address by revising scope of other AMPs.
3. Parameters Monitored/Inspected		
The program relies on the use of transient acoustic signals to provide information on the occurrence of metallic loose part impact. Reactor coolant system (RCS) background noise may mask the noise generated due to loose part impact. These background noises may arise from sources such as coolant flow and mechanically and hydraulically generated vibrations. To differentiate loose part impact noise from background noise, ASME OM-S/G-1997, Part 12, recommends that the monitoring system sensitivity be set on the basis of the background noise and that maximum sensitivity be accomplished that is consistent with an acceptable false alarm rate arising from the background noise.		
3.1: The instance of, and costs associated with, false positives generated via acoustic emission based monitoring in the past implementations may have resulted in the abandonment of this AMP.	Updated technology and refined equipment capable of acceptable performance should be a better approach than basing the program elimination on inadequacy of a monitoring technique.	Suggest and encourage the industry to perform a state-of-the-art technology survey and to develop better and more reliable online monitoring.
4. Detection of Aging Effects		
Impact signals contain significant information on the size of the impacting object, the impact force and energy, and the composition and shape of both the component struck and the impacting object. In general, the magnitude of the impact signal increases with the impact mass and impact velocity. However, the frequency response increases with increasing velocity and decreasing mass. These data may be used to extract information on possible loose part impact and differentiate it from background noise.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4.1: No significant concern or further review item was identified.		
5. Monitoring and Trending		
The impact signals, collected data, frequency, and characteristics are recorded, monitored, and evaluated to locate and identify the source and cause of the acoustic signals for the purpose of determining the need and urgency for a detailed inspection and examination of the suspected reactor vessel internals components. These activities are performed and associated personnel are qualified in accordance with site controlled procedures and processes, as indicated by vendor, industry, or regulatory guidance documents.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
The LPM alarms that suggest metallic impacts are further evaluated to verify LPM operability and to determine the location of the impact, the impact energy, and mass. Plant process data are reviewed for anomalous behavior, and diagnostic results are assessed by plant personnel.		
6.1: No significant concern or further review item was identified.		
7. Corrective Actions		
If LPM diagnostics indicate the presence of loose parts, then corrective actions are taken. In some cases, the results of the diagnostic may indicate the signal is due to a change in the plant background noise characteristics and not due to the presence of loose parts. In such cases, the LPM alarm rates may in time become so high as to be unacceptable in practice. Adjustment of the alarm threshold (set points) is allowed. However, the reason for the change in background noise is to be investigated and understood, and the set point change is to be documented. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
See Item 8, above.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
The loose part monitoring program is extensively and effectively used by the industry. The program has been developed and published as a standard in the ASME "Standards and Guides for Operation and Maintenance of Nuclear Power Plants," Part 12, an American National Standard. Part 12 was developed on the basis of knowledge gained from operating experience and research conducted since the Nuclear Regulatory Commission (NRC) issued Regulatory Guide (RG) 1.133 in May 1981.		
10.1: The as-stated usage by the industry does not seem to match the stated basis in NUREG-1950 for eliminating this AMP.	The lessons learned from prior industry experience and regulatory guidance seems to suggest the significance of LPM.	Reconcile the positions.
10.2: Since there is no specific requirement for the LPM AMP, the licensee may not have an explicit plan to address some of the potential issues that are otherwise likely to be addressed to some extent by other existing programs, for example, under ASME Section XI ISI (AMP XI.M1), bolting integrity (AMP XI.M18), one time inspections (AMP XI.M32), and the plant NDE/monitoring program in general.	It is possible that the related concerns are being addressed in some other fashion on a plant-specific basis, and/or determined by an engineering analysis to be not significant (at least from a safety point of view). If so, it may be relevant to get feedback from the plant personnel with regard to the following: (a) Have there been any instance(s) of loose parts and/or associated damage, or unexpected locations/damage identified in the RCS and core internals? (b) What actions or measures were taken to address these instances? (c) What approach or technique is used to locate/identify such unspecified damage as may result from loose parts (including foreign objects) and/or flow anomalies within the RCS/RPV, and to determine the need/urgency for the relevant inspection/action? (d) What procedures, precautions, and practices are in	Survey industry-wide response, including the suggested feedback, to confirm or adjust the impact of eliminating this monitoring program or its non-relevance to the PEO.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	place to ensure that such degradation does not occur or is adequately managed to maintain the required functionality during normal and emergency operation? (e) [More specific to a BWR:] Has there been an issue with regard to the incore instrumentation tube vibrations and/or localized core flow anomalies? If so, what was the response, and if not, is there some (design or operational) basis to expect the good performance to continue into the PEO?	

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2005.

10 CFR Part 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ANSI S2.11-1969, *American National Standard for the Selection of Calibrations and Tests for Electrical Transducers Used for Monitoring Shock and Vibrations*, American National Standards Institute, Washington, DC, 1969.

ASME OM-S/G-1997, Part 12, *Loose Part Monitoring in Light-Water Reactor Power Plants*, American Society of Mechanical Engineers, New York, NY, 1997.

NRC Regulatory Guide 1.133, Rev. 1, *Loose Part Detection Program for the Primary System of Light Water Cooled Reactors*, U.S. Nuclear Regulatory Commission, 1981.

A.14 XI.M15 Neutron Noise Monitoring

The program description and description of the 10 program elements of GALL, Rev. 1, AMP XI.M15, Neutron Noise Monitoring, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on a visit to Ginna is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program relies on monitoring the excore neutron detector signals due to core motion to detect and monitor significant loss of axial preload at the core support barrel's upper support flange in pressurized water reactors (PWRs). This inservice monitoring program is based on the recommendations from the American Society of Mechanical Engineers operation and maintenance standards and guides (ASME OM-S/G)-1997, Part 5, "Inservice Monitoring of Core Support Barrel Axial Preload in Pressurized Water Reactors Power Plants."		
a.1: As stated in NUREG-1950 (Bases document for GALL, Rev. 2) the AMP XI.M15 was eliminated due to lack of relevance and very limited previous usage in submitted LRAs.	In the absence of a well-supported and documented basis for elimination of this program, the specific loss of preload and attendant core barrel vibration during normal mode in the PEO are presumed to be insignificant or adequately managed indirectly through results from other AMPs during an outage for related inspections.	Reassess the reasons for eliminating this AMP and its relevance for the PEO.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 1, AMP includes the basis document ASME OM-S/G-1997, Part 5, as part of its program description.		
b.1: Additional documents listed at the end of this worksheet provide further supporting information for this AMP.	The basis and recommendations from these additional documents seem relevant to the AMP objectives for the PEO.	Assess AMP need.
Program Consistency and Commitments		
The SER for Ginna did not review this AMP. Therefore, no related consistency review or commitments for the PEO were applicable to Ginna.		
c.1: There is no requirement for implementing this AMP, per Rev. 2 of the GALL Report.	Reassessment of online Neutron Noise Monitoring seems relevant for the PEO.	Review the requirements.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1. Scope of Program		
The program includes measures to monitor and detect loss of axial preload (loss of axial restraint) at the core support barrel's upper support flange in PWRs. The loss of axial restraint may arise from long-term changes resulting from abnormal wear at the reactor vessel core barrel mating surface or short-term changes due to improper installation of the reactor internals. The program also includes guidelines for further data acquisition that may be needed to define future plant operation and/or program plans in order to maintain the capability of the structure/components to perform the intended function.		
1.1: The scope of program of the GALL AMP XI.M15 includes both monitoring and detection of loss of axial preload at the upper support flange of the core support barrel, and provides an early indication of the onset of aging-related degradation of the hold-down mechanism prior to a scheduled shutdown for timely action. It is not clear how effectively this functionality can be ascertained during operation based on the periodic inspections performed under ASME Section XI, IWB ISI AMP and Reactor Vessel Internals (RVI) AMP, and how an early indication of the onset of degradation prior to shutdown is achieved by these periodic inspections.	The possibility of abnormal wear and/or improper installation can lead to impairment of functionality during operation without the benefit of early detection for timely action. The ISI and RVI programs do not cover the intended monitoring aspect and may give only an indirect indication of aging-related loss of preload during periodic inspections.	Reconsider an appropriately scoped AMP incorporating better/more reliable techniques of online monitoring as they are developed.
2. Preventive Actions		
The program is a monitoring/detection program that provides early indication and detection of the onset of aging degradation of the core support barrel holddown mechanism prior to a scheduled shutdown, thus reducing outage time and avoiding potential damage to the core support barrel and fuel assemblies. The AMP does not rely on preventive actions.		
2.1: Since this is not a preventive AMP there is no assurance, as discussed above in item 1.1, that the need for early indication and detection of significant loss of related functionality during operation has been eliminated.	Monitoring and early detection of aging effects from possible loss of preload and/or wear related vibrations may need to be reconsidered, or at least ensured to have been addressed adequately by other AMPs or plant-specific actions.	Address, if possible, by revising scope of other AMPs.
3. Parameters Monitored/Inspected		
The program relies on the use of excore neutron detector signals to provide information on the conditions of the axial preload. The excore neutron flux signal is composed of a steady state, direct current (DC) component that arises from the neutron flux produced by the power operation of the reactor, as well as a fluctuating (noise-like) component. This fluctuating signal arises from the core reactivity changes due		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
to lateral core motion from the loss of axial preload. This core motion is mainly the result of beam mode vibration of the core support barrel. Despite the fact that this beam mode vibration provides only a very weak neutron noise source, it may be reliably detected and identified through Fourier Analysis of the fluctuating signal component of the excore neutron flux signal. This signal component has the characteristics of having 180-degree shifts and a high degree of coherence between signals obtained from pairs of excore neutron detectors that are positioned on diametrically opposite sides of the core. The neutron noise signals are characterized by parameters, which include the auto correlation, cross correlation, coherence, and phase. These parameters are to be monitored and evaluated.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
Flow-induced vibration of the core support barrel will change the thickness of the downcomer annulus (water gap). This variation in the thickness will give rise to fluctuating changes in the neutron flux, as monitored by the excore neutron detectors. The natural frequencies and the amplitudes of the vibratory motion of the core barrel are related to the effective axial preload at the upper support flange of the core support barrel. Monitoring of the neutron noise signal obtained with the neutron flux detectors located around the external periphery of the reactor vessel provides detection of anomalous vibrational motion of the core support barrel, and hence significant loss of the axial preload. Decrease in the axial preload leads to decreases in the core support barrel beam mode frequency and an increase in the magnitude of the noise signal. The overall effect of a decrease in the axial preload is to shift the neutron noise power spectrum toward larger amplitudes for the lower frequency region.		
4.1: No further review item was identified.		
5. Monitoring and Trending		
The neutron noise random fluctuation in the signals from the excore detectors are monitored, recorded, and analyzed to identify changes in the beam mode natural frequency of the core support barrel and its direction of motion for the purpose of a timely determination of the need and urgency for a detailed inspection and examination of the reactor vessel internals hold-down mechanism and mating component surfaces. These activities and analytical methodology are performed, and associated personnel are qualified, in accordance with site-controlled procedures and processes as indicated by vendor, industry, or regulatory guidance documents. The neutron noise monitoring program has three separate phases: a baseline phase, a surveillance phase, and a diagnostic phase. The baseline phase establishes the database to be used as a reference for developing limits and trends in the surveillance phase and to support data evaluation and interpretation in the diagnostic phase. During the baseline phase, data on the time history and DC level of each neutron flux detector and each cross-core detector pair are obtained. From this database, the characteristic amplitudes and frequencies of the core barrel motion are extracted. The wide and narrow frequency bands with their associated normalized root mean square (NRMS) values are established. The ASME-OMS/G-1997, Part 5, recommends collecting the baseline data during the first fuel cycle that the neutron noise monitoring program is applied to an already operating plant. Whenever significant changes takes place for the core, reactor internals, or operating conditions, additional baseline data is obtained.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
In the surveillance phase, routine neutron noise monitoring of normal plant operations is performed over the life of the plant. The DC level and data for frequency analysis of each detector and two pair of cross-core detectors, may be collected. Comparisons of the measured amplitude and frequency data, with limits established from the baseline data, are made. In using neutron noise monitoring, accounts are taken of the effect of core burn-up, decreasing boron concentration, changes in fuel management, and in-core contact with the reactor vessel mechanical snubbers, which may affect the neutron noise signatures. Proper allowances for these factors during the baseline and surveillance phases will help toward detecting loss of axial preload before the core barrel becomes sufficiently free to wear against the reactor vessel and will also reduce the need to invoke the diagnostic phase. If the diagnostic phase becomes necessary, then evaluations are carried out to establish whether any deviations from the baseline data detected during the surveillance phase arises from core barrel motion due to loss of axial preload. The need and frequency of additional data collection on the time history and DC level of each neutron flux detector and each cross-core detector pair collection are guided by the results of these evaluations.		
5.1: The current revision of the GALL report (Rev. 2) does not include this neutron noise monitoring – this may result in licensee's reliance on the periodic ISI (ASME Section XI, IWB) and Reactor Vessel Internals AMP (during an outage), both of which do not cover the intended monitoring aspect and may give only an indirect or unspecified indication of aging-related loss of preload.	The monitoring for abnormal core support response and vibrations during operation is as relevant during the PEO, as during the current period of license.	Reconsider or evaluate the basis for the elimination of this AMP.
6. Acceptance Criteria		
If evaluation of the baseline data indicates normal operation for the applicable structure/component, the surveillance phase may commence. If evaluation indicates anomalous behavior, the monitoring program enters the diagnostic phase. During the surveillance phase, if deviations from the baseline fall within predetermined acceptable limits, the surveillance will continue. Otherwise, the diagnostic phase will commence.		
6.1: No further review item was identified.		
7. Corrective Actions		
Initial results from the diagnostic phase of the program may be used to determine whether there is a need to increase the minimum frequency with which the surveillance data are acquired. In addition, if necessary, corrective actions may be taken to change the type of data acquisition and analysis from that previously recommended for the surveillance part of the program. The data trends may be established to guide further data acquisition that may be needed to define future plant operation and/or program plans. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
See Item 8, above.		
9.1: No further review item was identified.		
10. Operating Experience		
The neutron noise monitoring program and procedures were developed by the industry and published as a guide in ASME OM-S/G-1997, Part 5. This monitoring program and procedures have been effective in limited industry use for monitoring and detecting loss of core support barrel axial preload in PWR.		
10.1: A concern is how well the past performance will guarantee the future reliability, in confirming or demonstrating that the neutron noise monitoring is not needed to ensure the functionality of core support barrel flange.	Further work is relevant to assess the significance of this monitoring based on plant database and operating experience to verify if any increase in clearance(s) and/or wear of mating surfaces at the barrel upper support area were observed in the related inspections or past history of operation. In addition, in cases of extended power uprates coupled with the possibility of long-term operation, effective online monitoring should be used.	Survey industry-wide OE and practices to confirm or adjust the impact of eliminating this monitoring program or its non-relevance to the PEO.
10.2: As a matter of design it may be possible to confirm that the hold down spring provides a preload to limit the	It would be relevant to support the possibility that any increase in clearance(s) and/or wear of mating surfaces at	Confirm the assessment

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
axial motion of the upper and lower internals assemblies, preventing lift-off of the core barrel flange from the vessel ledge. The spring preload would also reduce the lateral motion of the upper support plate flange and the core barrel flange. The hold down spring is required to be designed for operating condition loads (IAEA-TECDOC-1557). If confirmed, this could help provide a basis for reduced need for this AMP.	the barrel upper support area (between inspections) are assumed to be small enough to have minimal impact on the loss of preload and/or axial restraint, and have been rectified, if needed, during the outage to adequate preloading during the subsequent period of operation.	used to determine and/or manage the loss of axial preload based on the periodic inspections performed under ISI and RVI programs.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2005.

10 CFR Part 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2005.

ASME OM-S/G-1997, Part 5, *Inservice Monitoring of Core Support Barrel Axial Preload in Pressurized Water Reactor Power Plants*, American Society of Mechanical Engineers, New York, NY, 1997.

A.15 XI.M16A PWR Vessel Internals

The verbatim text of GALL, Rev. 2, AMP XI.M16A, PWR Vessel Internals, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to Ginna plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program relies on implementation of the Electric Power Research Institute (EPRI) Report No. 1016596 (MRP-227) and EPRI Report No. 1016609 (MRP-228) to manage the aging effects on the reactor vessel internal (RVI) components. This program is used to manage the effects of age-related degradation mechanisms that are applicable in general to the PWR RVI components at the facility. These aging effects include (a) various forms of cracking, including stress corrosion cracking (SCC), which also encompasses primary water stress corrosion cracking (PWSCC), irradiation-assisted stress corrosion cracking (IASCC), or cracking due to fatigue/cyclical loading; (b) loss of material induced by wear; (c) loss of fracture toughness due to either thermal aging or neutron irradiation embrittlement; (d) changes in dimension due to void swelling; and (e) loss of preload due to thermal and irradiation-enhanced stress relaxation or creep. The program applies the guidance in MRP-227 for inspecting, evaluating, and, if applicable, dispositioning non-conforming RVI components at the facility. The program conforms to the definition of a sampling-based condition monitoring program, as defined by the Branch Technical Position RSLB-1, with periodic examinations and other inspections of highly-affected internals locations. These examinations provide reasonable assurance that the effects of age related degradation mechanisms will be managed during the period of extended operation. The program includes expanding periodic examinations and other inspections if the extent of the degradation effects exceeds the expected levels. The MRP-227 guidance for selecting RVI components for inclusion in the inspection sample is based on a four-step ranking process. Through this process, the reactor internals for all three PWR designs were assigned to one of the following four groups: Primary, Expansion, Existing Programs, and No Additional Measures components. Definitions of each group are provided in GALL Chapter IX.B. The result of this four-step sample selection process is a set of Primary Internals Component locations for each of the three plant designs that are expected to show the leading indications of the degradation effects, with another set of Expansion Internals Component locations that are specified to expand the sample should the indications be more severe than anticipated. The degradation effects in a third set of internals locations are deemed to be adequately managed by Existing Programs, such as ASME Code, Section XI,[2] Examination Category B-N-3 examinations of core support structures. A fourth set of internals locations are deemed to require no additional measures.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.
[2] Refer to the GALL Report, Chapter I, for applicability of various editions of the ASME Code, Section XI.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
As a result, the program typically identifies 5 to 15% of the RVI locations as Primary Component locations for inspections, with another 7 to 10% of the RVI locations to be inspected as Expansion Components, as warranted by the evaluation of the inspection results. Another 5 to 15% of the internals locations are covered by Existing Programs, with the remainder requiring no additional measures. This process thus uses appropriate component functionality criteria, age-related degradation susceptibility criteria, and failure consequence criteria to identify the components that will be inspected under the program in a manner that conforms to the sampling criteria for sampling-based condition monitoring programs in Section A.1.2.3.4 of NRC Branch Position RLSB-1. Consequently, the sample selection process is adequate to assure that the intended function(s) of the PWR reactor internal components are maintained during the period of extended operation. The program's use of visual examination methods in MRP-227 for detection of relevant conditions (and the absence of relevant conditions as a visual examination acceptance criterion) is consistent with the ASME Code, Section XI rules for visual examination. However, the program's adoption of the MRP-227 guidance for visual examinations goes beyond the ASME Code, Section XI visual examination criteria because additional guidance is incorporated into MRP-227 to clarify how the particular visual examination methods will be used to detect relevant conditions and describes in more detail how the visual techniques relate to the specific RVI components and how to detect their applicable age-related degradation effects. The technical basis for detecting relevant conditions using volumetric ultrasonic testing (UT) inspection techniques can be found in MRP-228, where the review of existing bolting UT examination technical justifications has demonstrated the indication detection capability of at least two vendors, and where vendor technical justification is a requirement prior to any additional bolting examinations. Specifically, the capability of program's UT volumetric methods to detect loss of integrity of PWR internals bolts, pins, and fasteners, such as baffle-former bolting in B&W and Westinghouse units, has been well demonstrated by operating experience. In addition, the program's adoption of the MRP-227 guidance and process incorporates the UT criteria in MRP-228, which calls for the technical justifications that are needed for volumetric examination method demonstrations, required by the ASME Code, Section V. The program also includes future industry operating experience as incorporated in periodic revisions to MRP-227. The program thus provides reasonable assurance for the long-term integrity and safe operation of reactor internals in all commercial operating U.S. PWR nuclear power plants. Age-related degradation in the reactor internals is managed through an integrated program. Specific features of the integrated program are listed in the following ten program elements. Degradation due to changes in material properties (e.g., loss of fracture toughness) was considered in the determination of inspection recommendations and is managed by the requirement to use appropriately degraded properties in the evaluation of identified defects. The integrated program is implemented by the applicant through an inspection plan that is submitted to the NRC for review and approval with the application for license renewal.		
a.1: "Program Description" in GALL AMP XI.M12 states: "Aging management of CASS reactor internal components of pressurized water reactors (PWRs) are discussed in AMP XI.M16A." However, GALL AMP XI.16A does not	In MRP-227, Section 3.3.2, "Categorization and Aging Management Strategy Development," Table 3-1 to 3-3, the following CASS components are considered primary components: (1) B&W Internals: Core support shield cast	Revise relevant program elements of

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
mention irradiation and/or thermal embrittlement of CASS materials in PWRs. This AMP should provide guidance regarding the neutron and thermal embrittlement of CASS reactor internal components and potential synergistic effects of the two.	outlet nozzle and vent valve discs, and incore monitoring instrumentation (IMI) guide tube spiders. (2) Westinghouse: control rod guide tube (CRGT) assembly lower flanges. The following are considered expansion components: (1) B&W Internals: CRGT spacer castings; (2) CE Internals: Lower core support columns; and (3) Westinghouse: Lower core support column bodies.	the AMP to provide guidance regarding thermal and neutron embrittlement of CASS materials.
a.2: Section A.6.1, "Thermal Embrittlement," of the EPRI Materials Degradation Matrix (MDM) (Rev. 1) report states that the synergistic effect of thermal and neutron embrittlement has been identified as a potential concern by the NRC staff (in Section XI.M13 of NUREG-1801, Rev.1). However, it further adds that no data have been presented so far to prove or disprove the existence of such synergistic effects; some researchers discount this possibility since thermal aging affects the ferrite much more than irradiation for relevant neutron doses, and CASS is not expected to experience high enough irradiation doses to cause irradiation effects on the austenite.	The second statement in the MDM report is not entirely correct. First, it is not known whether the combined effects of thermal aging and neutron irradiation on ferrite would decrease fracture toughness more than thermal aging alone, and secondly, neutron embrittlement of austenite starts at 0.5 dpa and fracture toughness can decrease to about 38 MPa $m^{1/2}$ at about 4.5 dpa (at 290-300°C). Several CASS internal components, listed above, are likely to exceed these levels of neutron dose during the PEO.	Revise relevant program elements of the AMP to include synergistic effects.
a.3: To ensure that the effects of aging on the reactor vessel internals would be adequately managed so that the components' intended functions would be maintained consistent with the current licensing basis for the period of extended operation, the applicant should review its design basis analyses in the final safety analysis report (FSAR) and other relevant documents and identify additional TLAAs or design evaluations that may be needed.	The MRP-227 report does not provide an assessment of the effect of long-term exposure to neutron irradiation on the mechanical properties of reactor vessel internal components and its impact on the licensing basis. In particular, whether the requirements of ASME Code Section III Subsections NB/NG-2160, NB/NG-3121, or NB/NG-3124, which are related to various aging effects on mechanical properties of reactor structural material, remain valid during the extended period. The applicant should provide (a) an assessment of neutron fluence for specific reactor vessel internal components to define threshold fluence for susceptibility to IASCC, neutron embrittlement, void swelling, irradiation creep, or irradiation assisted stress	Revise the program description to include the suggested guidance.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	relaxation; and (b) a methodology for estimation of the reduction in fracture toughness and ductility of reactor internals.	
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP for PWR vessel internals essentially implements the inspection and evaluation guidance provided in the following: 1. MRP-227-A, EPRI 1022863, *Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines*, Dec. 2011. 2. MRP-228, EPRI 1016609, *Materials Reliability Program: Inspection Standard for PWR Internals*, July 2009. 3. WCAP-17096-NP, Rev. 2, Reactor Internals Acceptance Criteria Methodology and Data Requirements, Dec. 2011 (or latest NRC-approved revision).		
b.1: The MRP-227 SER states that the guidance in WCAP-17096-NP, Rev. 2, will be used as the framework to develop those generic and plant-specific evaluations triggered by findings in the RVI examinations. The NRC staff is currently reviewing the report.	The WCAP-17096-NP, Rev. 2, report does not provide any details for determining the reduction in fracture toughness and the ductility of reactor core internal components; for defining the allowable flaw size; or the SCC, fatigue, or corrosion fatigue crack growth rates that will be used to perform flaw tolerance evaluation and in defining the adequate inspection intervals. The staff should ensure that the WCAP-17096 report and this AMP should include acceptable methodology for estimating reduction in fracture toughness and ductility, and allowable mathematical predicting expressions for crack growth rates for reactor core internal materials such as SSs, Ni-alloys, and low-alloy steels.	Revise the program description to include the suggested guidance and Ref. WCAP-17096.
Program Consistency and Commitments		
The applicant stated that it had implemented a plant-specific AMP consistent with the inspection and evaluation guidelines in MRP-227, Rev. 0, and will update its program through a comparison with MRP-227-A to determine its path forward to achieve consistency with MRP-227-A.		
c.1: (Ginna plant visit) The Ginna AMP, submitted to NRC for review and approval, consists of (a) an identification of the most susceptible or limiting RVI components and	With the issuance of MRP-227-A and consistent with the guidance of RIS 2011-07, Ginna stated that it will withdraw its RVI program submitted for NRC review and approval,	Update program the description

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
locations; (b) development of appropriate inspection techniques to permit the detection and characterizing features of interest (fine cracks) and demonstrate the effectiveness of the proposed method; and (c) the implementation of the augmented inspections during the license renewal term. However, this program was not reviewed pending acceptability of the industry program, as embodied in the MRP-227.	and re-submit a revised program within 1 year that will be consistent with the guidelines in WCAP-14577-1A and MRP-227-A. This AMP offers an unusual situation in that the examinations that have been implemented by Ginna are not necessarily reflective of those that will be implemented to achieve consistency with MRP 227-A during the PEO.	based on MRP-227-A and its SER, and include Ref. MRP-227-A.
1. Scope of Program		
The scope of the program includes all RVI components at the [*as an administrative action item for the AMP, the applicant to fill in the name of the applicant's nuclear facility, including applicable units*], which [*is/are*] built to a [*applicant to fill in Westinghouse, CE, or B&W, as applicable*] NSSS design. The scope of the program applies the methodology and guidance in the most recently NRC-endorsed version of MRP-227, which provides augmented inspection and flaw evaluation methodology for assuring the functional integrity of safety-related internals in commercial operating U.S. PWR nuclear power plants designed by B&W, CE, and Westinghouse. The scope of components considered for inspection under MRP-227 guidance includes core support structures (typically denoted as Examination Category B-N-3 by the ASME Code, Section XI), those RVI components that serve an intended license renewal safety function pursuant to criteria in 10 CFR 54.4(a)(1), and other RVI components whose failure could prevent satisfactory accomplishment of any of the functions identified in 10 CFR 54.4(a)(1)(i), (ii), or (iii). The scope of the program does not include consumable items, such as fuel assemblies, reactivity control assemblies, and nuclear instrumentation, because these components are not typically within the scope of the components that are required to be subject to an aging management review (AMR), as defined by the criteria set in 10 CFR 54.21(a)(1). The scope of the program also does not include welded attachments to the internal surface of the reactor vessel because these components are considered to be ASME Code Class 1 appurtenances to the reactor vessel and are adequately managed in accordance with an applicant's AMP that corresponds to GALL AMP XI.M1, "ASME Code, Section XI Inservice Inspection, Subsections IWB, IWC, and IWD." The scope of the program includes the response bases to applicable license renewal applicant action items (LRAAIs) on the MRP-227 methodology, and any additional programs, actions, or activities that are discussed in these LRAAI responses and credited for aging management of the applicant's RVI components. The LRAAIs are identified in the staff's safety evaluation on MRP-227 and include applicable action items on meeting those assumptions that formed the basis of the MRP's augmented inspection and flaw evaluation methodology (as discussed in Section 2.4 of MRP-227), and NSSS vendor-specific or plant-specific LRAAIs as well. The responses to the LRAAIs on MRP-227 are provided in Appendix C of the LRA. The guidance in MRP-227 specifies applicability limitations to base-loaded plants and the fuel loading management assumptions upon which the functionality analyses were based. These limitations and assumptions require a determination of applicability by the applicant for each reactor and are covered in Section 2.4 of MRP-227.		
1.1: As stated above, the scope of the program includes the	Since most of the aging degradation processes for the RVI	Revise scope

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response bases to applicable license renewal AAIs on the MRP-227 methodology, and any additional programs, actions, or activities that are discussed in these AAI responses and credited for aging management of the applicant's reactor vessel internal components. AAI #1 discusses the applicability of FMECA (failure mode, effects, and criticality analysis) and functional analysis assumptions, and AAI #3 discusses the adequacy of plant-specific existing programs. However, neither of these AAIs give any details as to which specific issues/concerns need to be addressed in these assessments to verify the applicability of MRP-227 guidance, including plant-specific AMPs, to the applicant's facility.	components are related to neutron irradiation effects, an inclusion of TLAA or an engineering evaluation of neutron fluence for specific reactor vessel internal components would be warranted, to define the threshold fluence for various degradation processes, such as susceptibility to degradation processes such as IASCC, neutron embrittlement, void swelling, irradiation creep, or irradiation-assisted stress relaxation. Such evaluations are commonly used to establish acceptable crack growth rates or estimate the reduction in ductility and fracture toughness for reactor vessel internals, which are needed to perform flaw growth and flaw tolerance analysis to determine adequate inspection interval for RVIs. Furthermore, any flaw tolerance and crack growth analyses that are performed as part of the design bases and are part of the current licensing bases must be updated to include the effects of reduced ductility and fracture toughness and potentially higher crack growth rates.	of program to include the suggested guidance.
1.2: Most plants include fatigue cumulative usage factor (CUF) analyses for fatigue-sensitive RVI components to meet the ASME Code Section III, Subsection NG requirements. Some plants disposition these fatigue TLAAs using the 10 CFR 54.21(c)(1)(iii) option, and instead of updating the analyses to include the PEO, propose an inspection program such as that described in MRP-227-A to manage aging effects of fatigue damage.	For plants using the 10 CFR 54.21(c)(1)(iii) option to disposition the fatigue CUF analyses, ensure that the applicant's response to AAI #8 includes a postulated flaw tolerance and growth analysis, including the effects of reactor coolant and neutron irradiation environment to justify the adequacy of the inspection interval (consistent with MRP-227 SER Section 3.5.1 item 5).	Revise the scope of the program to include the suggested guidance.
1.3: The license renewal AAI #7 asks the applicant to develop a plant-specific evaluation to demonstrate that the reactor internal components constructed of CASS will maintain their functions during the period of extended operation. These analyses consider the possible loss of fracture toughness due to thermal and neutron embrittlement.	This recommendation in MRP-227, Rev. 0, SER is not consistent with GALL, Rev. 1, AMP XI.M13, which specifically states that the program should also address the synergistic effects of thermal and neutron embrittlement. The MRP-227 guidance (or this AMP) should incorporate a methodology for estimating the loss of fracture toughness of RVI components constructed from CASS materials that considers the synergistic effects of thermal aging	Revise the scope of the program to include the suggested guidance.

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	embrittlement and neutron irradiation embrittlement.	
2. Preventive Actions		
The guidance in MRP-227 relies on PWR water chemistry control to prevent or mitigate aging effects that can be induced by corrosive aging mechanisms (e.g., loss of material induced by general, pitting corrosion, crevice corrosion, or stress corrosion cracking or any of its forms [SCC, PWSCC, or IASCC]). Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation, and technical basis of water chemistry are presented in GALL AMP XI.M2, "Water Chemistry."		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
The program manages the following age-related degradation effects and mechanisms that are applicable in general to the RVI components at the facility: (a) cracking induced by SCC, PWSCC, IASCC, or fatigue/cyclical loading; (b) loss of material induced by wear; (c) loss of fracture toughness induced by either thermal aging or neutron irradiation embrittlement; (d) changes in dimension due to void swelling and irradiation growth, distortion, or deflection; and (e) loss of preload caused by thermal and irradiation-enhanced stress relaxation or creep. For the management of cracking, the program monitors for evidence of surface breaking linear discontinuities if a visual inspection technique is used as the non-destruction examination (NDE) method, or for relevant flaw presentation signals if a volumetric UT method is used as the NDE method. For the management of loss of material, the program monitors for gross or abnormal surface conditions that may be indicative of loss of material occurring in the components. For the management of loss of preload, the program monitors for gross surface conditions that may be indicative of loosening in applicable bolted, fastened, keyed, or pinned connections. The program does not directly monitor for loss of fracture toughness that is induced by thermal aging or neutron irradiation embrittlement, or by void swelling and irradiation growth; instead, the impact of loss of fracture toughness on component integrity is indirectly managed by using visual or volumetric examination techniques to monitor for cracking in the components and by applying applicable reduced fracture toughness properties in the flaw evaluations if cracking is detected in the components and is extensive enough to warrant a supplemental flaw growth or flaw tolerance evaluation under the MRP-227 guidance or ASME Code, Section XI requirements. The program uses physical measurements to monitor for any dimensional changes due to void swelling, irradiation growth, distortion, or deflection. Specifically, the program implements the parameters monitored/inspected criteria for [*as an administrative action item for the AMP, applicant is to select one of the following to finish the sentence, as applicable to its NSSS vendor for its internals: "for B&W designed Primary Components in Table 4-1 of MRP-227"; "for CE designed Primary Components in Table 4-2 of MRP-227"; and "for Westinghouse designed Primary Components in Table 4-3 of MRP- 227"*]. Additionally, the program implements the parameters monitored/inspected criteria for [*as an administrative action item for the AMP, applicant is to select one of the following to finish the sentence, as applicable to its NSSS vendor for its internals: "for B&W designed Expansion Components in Table 4-4 of MRP-227"; "for CE designed Expansion Components in Table 4-5 of MRP-227"; and "for Westinghouse designed Expansion Components in Table 4-6 of MRP-227"*]. The		

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parameters monitored/inspected for Existing Program Components follow the bases for referenced Existing Programs, such as the requirements for ASME Code Class RVI components in ASME Code, Section XI, Table IWB-2500-1, Examination Categories B-N-3, as implemented through the applicant's ASME Code, Section XI program, or the recommended program for inspecting Westinghouse designed flux thimble tubes in GALL AMP XI.M37, "Flux Thimble Tube Inspection." No inspections, except for those specified in ASME Code, Section XI, are required for components that are identified as requiring "No Additional Measures," in accordance with the analyses reported in MRP-227.		
3.1: The program primarily monitors the effect of cracking on the intended function of the reactor internal components by detecting and sizing cracks by inspection. However, with continued operation, the total accumulated neutron dose also continues to increase. For example, for most reactor vessel internals, the total neutron dose at the end of the original 40-year operation period would exceed the thresholds for IASCC, neutron embrittlement, and stress relaxation, and for some components, is likely to exceed the thresholds for void swelling and irradiation creep.	It would, therefore, be prudent to monitor the total dose of select set of components to identify the potential for susceptibility to IASCC, neutron embrittlement, stress relaxation of bolted connections, void swelling, and/or irradiation creep, so that the management activities needed to adequately manage these aging degradations can be defined.	Revise Element 3 to include an assessment of degradation processes based on total neutron dose.
4. Detection of Aging Effects		
The detection of aging effects is covered in two places: (a) the guidance in Section 4 of MRP-227 provides an introductory discussion and justification of the examination methods selected for detecting the aging effects of interest; and (b) standards for examination methods, procedures, and personnel are provided in a companion document, MRP-228. In all cases, well-established methods were selected. These methods include volumetric UT examination methods for detecting flaws in bolting, physical measurements for detecting changes in dimension, and various visual (VT-3, VT-1, and EVT-1) examinations for detecting effects ranging from general conditions to detection and sizing of surface-breaking discontinuities. Surface examinations may also be used as an alternative to visual examinations for detection and sizing of surface-breaking discontinuities. Cracking caused by SCC, IASCC, and fatigue is monitored/inspected by either VT-1 or EVT-1 examination (for internals other than bolting) or by volumetric UT examination (bolting). The VT-3 visual methods may be applied for the detection of cracking only when the flaw tolerance of the component or affected assembly, as evaluated for reduced fracture toughness properties, is known and has been shown to be tolerant of easily detected large flaws, even under reduced fracture toughness conditions. In addition, VT-3 examinations are used to monitor/inspect for loss of material induced by wear and for general aging conditions, such as gross distortion caused by void swelling and irradiation growth or by gross effects of loss of preload caused by thermal and irradiation-enhanced stress relaxation and creep. In addition, the program adopts the recommended guidance in MRP-227 for defining the Expansion criteria that need to be applied to inspections of Primary Components and December 2010 XI M16A-5 NUREG-1801, Rev. 2 Existing Requirement Components and for		

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expanding the examinations to include additional Expansion Components. As a result, inspections performed on the RVI components are performed consistent with the inspection frequency and sampling bases for Primary Components, Existing Requirement Components, and Expansion Components in MRP-227, which have been demonstrated to be in conformance with the inspection criteria, sampling basis criteria, and sample Expansion criteria in Section A.1.2.3.4 of NRC Branch Position RLSB-1. Specifically, the program implements the parameters monitored/inspected criteria and bases for inspecting the relevant parameter conditions for [*as an administrative action item for the AMP, applicant is to select one of the following to finish the sentence, as applicable to its NSSS vendor for its internals: "B&W designed Primary Components in Table 4-1 of MRP- 227"; "CE designed Primary Components in Table 4-2 of MRP-227;" or "Westinghouse designed Primary Components in Table 4-3 of MRP-227"*] and for [*as an administrative action item for the AMP, applicant is to select one of the following to finish the sentence, as applicable to its NSSS vendor for its internals: "for B&W designed Expansion Components in Table 4-4 of MRP-227;" "for CE designed expansion components in Table 4-5 of MRP- 227;" and "for Westinghouse designed Expansion Components in Table 4-6 of MRP-227"*]. The program is supplemented by the following plant-specific Primary Component and Expansion Component inspections for the program (as applicable): [*As a relevant license renewal applicant action item, the applicant is to list (using criteria in MRP-227) each additional RVI component that needs to be inspected as an additional plant-specific Primary Component for the applicant's program and each additional RVI component that needs to be inspected as an additional plant-specific Expansion Component for the applicant's program. For each plant specific component added as an additional primary or Expansion Component, the list should include the applicable aging effects that will be monitored for, the inspection method or methods used for monitoring, and the sample size and frequencies for the examinations*]. In addition, in some cases (as defined in MRP-227), physical measurements are used as supplemental techniques to manage for the gross effects of wear, loss of preload due to stress relaxation, or for changes in dimension due to void swelling, deflection or distortion. The physical measurements methods applied in accordance with this program include [*Applicant to input physical measure methods identified by the MRP in response to NRC RAI No. 11 in the NRC's Request for Additional Information to Mr. Christen B. Larson, EPRI MRP on Topical Report MRP-227 dated November 12, 2009*].		
4.1: No further review item was identified.		
5. Monitoring and Trending		
The methods for monitoring, recording, evaluating, and trending the data that result from the program's inspections are given in Section 6 of MRP-227 and its subsections. The evaluation methods include recommendations for flaw depth sizing and for crack growth determinations as well for performing applicable limit load, linear elastic and elastic-plastic fracture analyses of relevant flaw indications. The examinations and reexaminations required by the MRP-227 guidance, together with the requirements specified in MRP-228 for inspection methodologies, inspection procedures, and inspection personnel, provide timely detection, reporting, and corrective actions with respect to the effects of the age-related degradation mechanisms within the scope of the program. The extent of the examinations, beginning with the sample of susceptible PWR internals component locations identified as Primary Component locations, with the potential for inclusion of Expansion Component locations if the effects are greater than anticipated, plus the continuation of the Existing Programs		

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activities, such as the ASME Code, Section XI, Examination Category B-N-3 examinations for core support structures, provides a high degree of confidence in the total program.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Section 5 of MRP-227 provides specific examination acceptance criteria for the Primary and Expansion Component examinations. For components addressed by examinations referenced to ASME Code, Section XI, the IWB-3500 acceptance criteria apply. For other components covered by Existing Programs, the examination acceptance criteria are described within the Existing Program reference document. The guidance in MRP-227 contains three types of examination acceptance criteria: • For visual examination (and surface examination as an alternative to visual examination), the examination acceptance criterion is the absence of any of the specific, descriptive relevant conditions; in addition, there are requirements to record and disposition surface breaking indications that are detected and sized for length by VT- 1/EVT-1 examinations; • For volumetric examination, the examination acceptance criterion is the capability for reliable detection of indications in bolting, as demonstrated in the examination Technical Justification; in addition, there are requirements for system-level assessment of bolted or pinned assemblies with unacceptable volumetric (UT) examination indications that exceed specified limits; and For physical measurements, the examination acceptance criterion for the acceptable tolerance in the measured differential height from the top of the plenum rib pads to the vessel seating surface in B&W plants are given in Table 5-1 of MRP-227. The acceptance criterion for physical measurements performed on the height limits of the Westinghouse-designed hold-down springs are [*The incorporation of this sentence is a license renewal applicant action item for Westinghouse PWR applicants only – insert the applicable sentence incorporating the specified physical measurement criteria only if the applicant's facility is based on a Westinghouse NSSS design: the Westinghouse applicant is to incorporate the applicable language and then specify the fit up limits on the hold down springs, as established on a plant-specific basis for the design of the hold-down springs at the applicant's Westinghouse-designed facility*].		
6.1: This AMP basically follows the ASME Section XI 10-year inspection interval for all highly irradiated reactor vessel internal components. Recent data indicate that exposure to neutron irradiation to 5–8 dpa decreases the fracture toughness J_{Ic} value of stainless steels from well above 200 kJ/m^2 to as low as 7.5 kJ/m^2 (or K_{Jc} of 38 MPa m$^{1/2}$) (NUREG/CR-7027, Dec. 2010). In addition, the crack growth rates for moderate to highly irradiated wrought and CASS can be a factor of 20 higher than those	While the initial aging effect is loss of ductility and fracture toughness, unstable and potentially rapid crack extension is the eventual aging effect, if a crack is present and the local applied stress intensity factor exceeds the reduced fracture toughness. In view of significant reduction in fracture toughness and very high SCC and fatigue crack growth rates, it would be prudent to verify the adequacy of the 10-year inspection interval. Furthermore, the potential effect of plant modifications such	Include validation of the 10-year inspection interval and effects of plant modifications to the RVI

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for non-irradiated stainless steels.	as EPU on flaw tolerance analyses should also be evaluated.	components.
7. Corrective Actions		
Corrective actions following the detection of unacceptable conditions are fundamentally provided for in each plant's corrective action program. Any detected conditions that do not satisfy the examination acceptance criteria are required to be dispositioned through the plant corrective action program, which may require repair, replacement, or analytical evaluation for continued service until the next inspection. The disposition will ensure that design basis functions of the reactor internals components will continue to be fulfilled for all licensing basis loads and events. Examples of methodologies that can be used to analytically disposition unacceptable conditions are found in the ASME Code, Section XI or in Section 6 of MRP-227. Section 6 of MRP-227 describes the options that are available for disposition of detected conditions that exceed the examination acceptance criteria of Section 5 of the report. These include engineering evaluation methods, as well as supplementary examinations to further characterize the detected condition, or the alternative of component repair and replacement procedures. The latter are subject to the requirements of the ASME Code, Section XI. The implementation of the guidance in MRP-227, plus the implementation of any ASME Code requirements, provides an acceptable level of aging management of safety-related components addressed in accordance with the corrective actions of 10 CFR Part 50, Appendix B or its equivalent, as applicable. Other alternative corrective action bases may be used to disposition relevant conditions if they have been previously approved or endorsed by the NRC. Examples of previously NRC-endorsed alternative corrective actions bases include those corrective actions bases for Westinghouse-design RVI components that are defined in Tables 4-1, 4-2, 4-3, 4-4, 4-5, 4-6, 4-7 and 4-8 of Westinghouse Report No. WCAP-14577-Rev. 1-A, or for B&W-designed RVI components in B&W Report No. BAW-2248. Westinghouse Report No. WCAP-14577-Rev. 1-A was endorsed for use in an NRC SE to the Westinghouse Owners Group, dated February 10, 2001. B&W Report No. BAW-2248 was endorsed for use in an SE to Framatome Technologies on behalf of the B&W Owners Group, dated December 9, 1999. Alternative corrective action bases not approved or endorsed by the NRC will be submitted for NRC approval prior to their implementation.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B, or their equivalent, as applicable. It is expected that the implementation of the guidance in MRP-227 will provide an acceptable level of quality for inspection, flaw evaluation, and other elements of aging management of the PWR internals that are addressed in accordance with the 10 CFR Part 50, Appendix B, or their equivalent (as applicable), confirmation process, and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
The administrative controls for such programs, including their implementing procedures and review and approval processes, are under		

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existing site 10 CFR 50 Appendix B Quality Assurance Programs, or their equivalent, as applicable. Such a program is thus expected to be established with a sufficient level of documentation and administrative controls to ensure effective long-term implementation.		
9.1: No further review item was identified.		
10. Operating Experience		
Relatively few incidents of PWR internals aging degradation have been reported in operating U.S. commercial PWR plants. A summary of observations to date is provided in Appendix A of MRP-227-A. The applicant is expected to review subsequent operating experience for impact on its program or to participate in industry initiatives that perform this function. The application of the MRP-227 guidance will establish a considerable amount of operating experience over the next few years. Section 7 of MRP-227 describes the reporting requirements for these applications, and the plan for evaluating the accumulated additional operating experience.		
10.1: (Ginna plant visit) The licensee specifically discussed the following examinations (and background) related to baffle bolts: With DC Cook finding baffle bolt heads at the bottom of its reactor pressure vessel (lower core support plate), additional criteria were added at Ginna to visually examine the bolt head welds (locking device) as a first step. o Surry operating experience of ~1–2 UT indications out of 1080 bolts inspected. o Beznau (Switzerland) found unsatisfactory UT results in 2009. o In 1999, Ginna replaced 56 out of 728 bolts. Although 14 were identified as having cracks, laboratory examination identified only 1 bolt with a crack, indicating that the UT method employed at that time was conservative. o Ginna's target was to demonstrate a minimum bolting pattern of 121 bolts plus a 50% margin would justify operation for 10 years, with an assumption that 50% of the 728 bolts failed. o Findings from inspections: ▪ Bolt removal rate was much slower than anticipated. ▪ In high fluence region, there were issues putting bolts back in, and 3 holes needed to be left open at the end of the outage. ▪ There was some fuel impingement and structural impact from jetting. ▪ 28 bolts were removed and UT from the back side (non-shank end) identified no issues.	The licensee stated that it considered baffle bolt OE at the DC Cook, Beznau (Switzerland), and Surry plants, and clevis pin insert screw experience from the Cook plant, as well as its plant-specific OE prior to implementation of its PWR Vessel Internals Program. The Ginna reactor vessel internals inspections included significant interactions with a DOE program that is addressing long-term plant operation. The results of these inspections are provided in various report and papers. In addition, adverse findings from the inspections are being documented through the MRP process and made available to the rest of the industry participants (all PWR licensees), and the inspection and evaluation guidelines being developed in MRP-227 will be modified accordingly. The use of plant-specific and industry-wide OE for updating and implementing the program is considered a good practice or strength of the AMP.	Revise program Element 10 to include such a recommendation.

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▪ UT was done on ~155 other bolts and only 1 indication was found. o Current plant-specific acceptance analysis for current conditions justifies one cycle of operation; Ginna will analyze and demonstrate acceptable operation until next 10-year ISI.		

References

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ASME Boiler & Pressure Vessel Code, Section V, *Nondestructive Examination*, 2004 Edition, American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

B&W Report No. BAW-2248, *Demonstration of the Management of Aging Effects for the Reactor Vessel Internals*, Framatome Technologies (now AREVA Technologies), Lynchburg VA, July 1997. (NRC Microfiche Accession Number A0076, Microfiche Pages 001 - 108).

EPRI 1014986, *PWR Primary Water Chemistry Guidelines*, Volume 1, Revision 6, Electric Power Research Institute, Palo Alto, CA, December 2007. (Non-publicly available ADAMS Accession Number ML081140278). The non-proprietary version of the report may accessed by members of the public at ADAMS Accession Number ML081230449

EPRI 1016596, *Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines* (MRP-227-Rev. 0), Electric Power Research Institute, Palo Alto, CA: 2008.

EPRI 1016609, *Materials Reliability Program: Inspection Standard for PWR Internals* (MRP- 228), Electric Power Research Institute, Palo Alto, CA, July 2009. (Non-publicly available ADAMS Accession Number ML092120574). The non-proprietary version of the report may accessed by members of the public at ADAMS Accession Number ML092750569.

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NRC Safety Evaluation from C. I. Grimes [NRC] to R. A, Newton [Chairman, Westinghouse Owners Group], *Acceptance for Referencing of Generic License Renewal Program Topical Report Entitled "License Renewal Evaluation: Aging Management for Reactor Internals,"* WCAP-14577, Revision 1, February 10, 2001. (ADAMS Accession Number ML010430375).

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NUREG-1800, Revision 2, *Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants*, Appendix A.1, "Aging Management Review - Generic (Branch Technical Position RLSB-1)," U.S. Nuclear Regulatory Commission, Washington, DC, 2010.

Westinghouse Non-Proprietary Class 3 Report No. WCAP-14577-Rev. 1-A, *License Renewal Evaluation: Aging Management for Reactor Internals*, Westinghouse Electric Company, Pittsburgh, PA [March 2001]. Report was submitted to the NRC Document Control Desk in a letter dated April 9, 2001. (ADAMS Accession Number ML011080790).

A.16 XI.M17 Flow-Accelerated Corrosion

The verbatim text of GALL, Rev. 2, AMP XI.M17, Flow-Accelerated Corrosion, is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program relies on implementation of the Electric Power Research Institute (EPRI) guidelines in the Nuclear Safety Analysis Center (NSAC)-202L-R2 or R3 for an effective flow-accelerated corrosion (FAC) program. The program includes performing (a) an analysis to determine critical locations, (b) limited baseline inspections to determine the extent of thinning at these locations, and (c) follow-up inspections to confirm the predictions, or repairing or replacing components as necessary. NSAC-202L-R2 or R3 provides general guidelines for the FAC program. To provide reasonable assurance that all the aging effects caused by FAC are properly managed, the program includes the use of a predictive code, such as CHECWORKS, that uses the implementation guidance of NSAC-202L-R2 or R3 to satisfy the criteria specified in 10 CFR Part 50, Appendix B, for development of procedures and control of special processes.		
a.1: The program description is inadequate to clearly define the degradation intended to be addressed in this AMP and to exclude several other types of degradation (e.g., erosion-corrosion, cavitation, impingement wear) not addressed. (Management of) FAC itself is significantly different between single-phase and two-phase systems. The materials affected by FAC include general carbon steels as well as low-alloy steels, especially with low chromium content (the threshold also dependent on single-phase versus two-phase flow). The components subject to FAC include piping elements, piping components, pressure boundary nozzles, safe-ends, vessel/shell walls, and some structural elements.	The aging effect addressed is that of wall-thinning resulting from the interaction between the flow characteristics and the corrosion product influenced by the material composition and water chemistry. Any reference to the erosion (in erosion-corrosion) in the context of FAC is limited to the action of (non-impacting or non-abrasive) mechanical removal of material from the corrosion product (usually some form of an oxide film or layer) and not directly from the base metal or original alloy material (underneath the corrosion product). Wall loss due to cavitation, impingement wear, or other similar mechanical effects is not addressed by this AMP.	Revise/expand the program description.
a.2: NSAC-202L-R2 or R3 is a general guidance document that forms an accepted basis for procedural and	The recognition of independence and need for integration of the noted three aspects is of significance to the overall	Revise/expand the

[1] Proposed NRC action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

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implementation guidelines for the organization, activities, and typical elements of an effective FAC program. However, the management of wall-thinning under the FAC AMP relies on success of three key and independent aspects of the program: (i) The general EPRI guidelines in the NSAC-202L-R2 or R3; (ii) CHECWORKS or a similar predictive tool or model to estimate the future wall-thinning rate and expected minimum wall prior to next inspection, with benchmarking and conservatism to address prediction uncertainty; and (iii) acceptance criteria.	structure and effectiveness of this AMP, which should be relevant part of the brief program description. It is also important to note that the original design and design basis do not address or account for wall loss due to FAC that, if for any reason undetected over a long period, has the potential to lead to sudden and unexpected component failure and loss of functionality, and that the leak-before-break concept is generally not expected to apply for such a degradation.	program description.
a.3: In item (a) of the description, it is not clear what (or how) analysis is to be performed to determine critical locations, and in item (b), it is not apparent why only limited baseline inspections would be adequate to manage the aging effect over long term operation. In addition, the reference to "all aging effects" being properly managed seems vague, particularly when only wall-thinning is addressed in the NSAC report and the CHECWORKS program.	Clarity of mandate and supporting basis for adequacy of the limited inspections under this AMP are important considerations for implementation and effectiveness of the AMP, especially when some locations are likely to remain uninspected when considering the period of extended operation.	Review the consideration s and revise the program description.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev., 2 AMP includes as part of its program description EPRI NSAC-202L-R2 or R3 and CHECWORKS as the primary basis documents.		
b.1: The actual plant-specific operating conditions and engineering judgment should be an important and integral part of the FAC program, especially in identifying and prioritizing the locations for inspection/monitoring. While these aspects are included in NSAC-202L-R2 or R3, these guidelines, as noted earlier, are fairly general.	The engineering judgment vis-à-vis plant conditions of relevance to FAC would be more effective and benefited if key documents are added as guidance. These include EPRI report TR-106611-R1 (1998) "Flow-Accelerated Corrosion in Power Plants," TR-106611-R1 (1998): EPRI Report 1011833, "Chemistry Effects on Flow-Accelerated Corrosion − Boiling Water Reactors: Dissolved Oxygen Investigation"; and EPRI Report 1013474, "Investigation into Flow-Accelerated Corrosion at Low Temperatures."	Review and add appropriate guidance or basis documents.
b.2: NSAC-202L-R2 or R3 and CHECWORKS do not	The objective of NSAC-202L-R2 or R3 is relevant to the	Review the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
address the acceptance criteria for FAC degradation. In addition, the stated objective of the current basis document, NSAC-202L-R3, is "To present a set of recommendations for nuclear power plants for implementing an effective program to detect and mitigate FAC."	program implementation aspect of detecting and mitigating FAC. This objective and the objective of GALL AMP need to be compared for adequacy or need supplementing for the intended aging management of long-term operation. Validation and comprehensive guidance on the applicable acceptance criteria with independently reviewed technical basis are also needed.	consideration s and add appropriate guidance or basis documents.
Program Consistency and Commitments		
This AMP at Ginna is based on Rev. 0 of the GALL report (2001), and the SER for Ginna LRA showed the AMP to be consistent with 2001 GALL Report, with exceptions but no enhancements or commitments. The LRA and related SER for NMP-1 showed that the FAC AMP implementation at NMP-1 is consistent with Rev. 0 of the GALL report (2001), with no deviations. During the audit, it was noted that Ginna removed service water piping and fire protection piping from the scope of the present AMP in 2009.		
c.1: No further review item was identified.		
1. Scope of Program		
The FAC program, described by the EPRI guidelines in NSAC-202L-R2 or R3, includes procedures or administrative controls to assure that the structural integrity of all carbon steel lines containing high-energy fluids (two-phase as well as single-phase) is maintained. Valve bodies retaining pressure in these high-energy systems are also covered by the program. The FAC program was originally outlined in NUREG-1344 and was further described through the Nuclear Regulatory Commission (NRC) Generic Letter 89-08.		
1.1: NSAC-202L-R2 or R3 incorporates "Long-term Strategy" as an essential part of a plant FAC program. For the period of extended operation the FAC AMP should expand on and address the key aspect(s) of this strategy as an important element to be integrated and assessed as part of the program scope.	According to the EPRI guideline strategy the FAC program should focus on reducing FAC wear rates, without which the number of needed inspections will increase with service time; even with selective repair and replacement, the likelihood of a consequential leak or rupture may increase with service time.	Revise the stated scope.
1.2: The factual statements in the program element description do not clarify or well characterize the extent of scope of this AMP.	As a minimum, the scope should include general carbon steels as well as low-alloy steels, especially with low chromium content, as the materials, and piping elements, piping components, pressure boundary nozzles, safe-ends, vessel/shell walls, and some structural elements as components subject to FAC.	Revise the stated scope.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1.3: Any reference to the erosion (in erosion-corrosion) in the context of FAC is limited to the action of (non-impacting or non-abrasive) mechanical removal of material from the corrosion product (usually some form of an oxide film or layer) itself, and not directly from the base metal or original alloy material (underneath the corrosion product). That is, this AMP does not address wall loss due to cavitation, impingement wear, or other similar mechanical effects.	GALL should be reviewed to verify that these aging effects are managed by other AMPs. If they are not, this program should either be enhanced or a new AMP developed to address the management of these aging effects.	Review GALL and enhance this AMP or develop new AMP as necessary
2. Preventive Actions		
The FAC program is an analysis, inspection, and verification program; no preventive action has been recommended in this program. However, it is noted that monitoring of water chemistry to control pH and dissolved oxygen content, and selection of appropriate piping material, geometry, and hydrodynamic conditions, are effective in reducing FAC.		
2.1: Monitoring, with enforcement, of specified controls on the water chemistry is needed to reduce the FAC incidence and wear rate. Effectiveness of this control and other selection of parameters as noted in the program element description is not uniformly applicable to assure the FAC mitigation for all systems (i.e., it is dependent on whether the FAC is under single phase flow or two-phase flow). These aspects need explicit recognition for the limitations of the actions under FAC AMP.	While the FAC program is not preventive in nature, one of its objectives is to prevent failure of a component as a result of the wall-thinning due to FAC. However, since the approach is based on inspection of a prioritized and limited sample of susceptible locations, it is recognized that preventing all FAC-related leaks and ruptures may not be possible. Therefore, the significance of aggressively adopting mitigative measures in the AMP needs emphasis for the program to be effective over the period of extended operation.	Revise the description indicating the need and limitations of various mitigative measures.
3. Parameters Monitored/Inspected		
The aging management program monitors the effects of loss of material due to wall thinning on the intended function of piping and components by measuring wall thickness.		
3.1: As an integral part of FAC AMP, for the intended purpose of predictive modeling (such as CHECWORKS), several parameters other than the wall thickness need to be monitored.	Monitored parameters should include those needed for predictive assessment as part of the AMP implementation. Any design modification or replacement resulting in a change of material or flow characteristics should be	Expand the list of items to be monitored or inspected for effective

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
A periodic review and confirmation of the basis of the exclusion list should be documented as part of this FAC program element. This exclusion list refers to locations that were excluded from further monitoring/inspection for specific reasons; these reasons need to be confirmed or affirmed in future reviews of the FAC inspection program as needed.	monitored in the immediate outage inspections, for both the new part and its downstream region, until the anticipated FAC mitigation is confirmed. The initial geometry (wall thickness) should be fully characterized and documented.	use of this AMP.
4. Detection of Aging Effects		
Degradation of piping and components occurs by wall thinning. The inspection program delineated in NSAC-202L-R2 or R3 consists of identification of susceptible locations, as indicated by operating conditions or special considerations. Ultrasonic or radiographic testing is used to detect wall thinning. A representative sample of components is selected based on the most susceptible locations for wall thickness measurements at a frequency in accordance with NSAC 202L guidelines to ensure that degradation is identified and mitigated before the component integrity is challenged. The extent and schedule of the inspections ensure detection of wall thinning before the loss of intended function		
4.1: No further review item was identified.		
5. Monitoring and Trending		
CHECWORKS or a similar predictive code is used to predict component degradation in the systems conducive to FAC, as indicated by specific plant data, including material, hydrodynamic, and operating conditions. CHECWORKS is acceptable because it provides a bounding analysis for FAC. The analysis is bounding because in general the predicted wear rates and component thicknesses are conservative when compared to actual field measurements. It is recognized that CHECWORKS is not always conservative in predicting component thickness; therefore, when measurements show the predictions to be non-conservative, the model must be re-calibrated using the latest field data. CHECWORKS was developed and benchmarked by comparing CHECWORKS predictions against actual measured component thickness measurements obtained from many plants. The inspection schedule developed by the licensee on the basis of the results of such a predictive code provides reasonable assurance that structural integrity will be maintained between inspections. Inspection results are evaluated to determine if additional inspections are needed to ensure that the extent of wall thinning is adequately determined, that intended function will not be lost, and that corrective actions are adequately identified. Previous wear rate predictions due to FAC may change after a power uprate is implemented. Wear rates are updated in CHECWORKS according to power uprate conditions. Subsequent field measurements are used to calibrate or benchmark the predicted wear rates.		
5.1: For those components that do not require immediate repair or replacement, according to the Acceptance Criteria	This is primarily an inspection-based condition monitoring program (i.e., it relies heavily on the inspection results	Revise or add to the text to

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
element, the inspection frequency is to be such that the repair or replacement occurs prior to reaching the wall thickness criteria. It also implies that the condition monitoring aspect of the program is not met if the observed wall thickness during any inspection is below the allowable limit, in which case an engineering evaluation and self-assessment of the monitoring and trending elements of the FAC program needs to be performed and adjustments made such that the operating experience is demonstrably bounded, and the root cause of failure to meet the expected performance has been identified and addressed in the program.	confirming that the predicted response conservatively bounds the observations made at that inspection). This confirmation must be made with respect to the projections for the minimum wall thickness and the wall-thinning rate. Engineering evaluation and self-assessment of these aspects of monitoring and trending at each inspection are essential for the future success of such a program in ensuring that the inspection interval and locations for inspections are adequate to manage this degradation or its aging effect of wall-thinning. Reasons (programmatic, operational, modeling, or model inputs) for re-calibration need to be addressed.	clarify the intent of monitoring and trending regarding the need for confirmation of bounding assessment.
6. Acceptance Criteria		
Inspection results are input for a predictive computer code, such as CHECWORKS, to calculate the number of refueling or operating cycles remaining before the component reaches the minimum allowable wall thickness. If calculations indicate that an area will reach the minimum allowed wall thickness before the next scheduled outage, corrective action should be considered.		
6.1: Under the FAC AMP, acceptance criteria are needed to disposition the as-observed wall-thinning or the as-predicted minimum wall at the end of next inspection interval. This disposition about repair, replacement, and inspection interval is based on criteria independent of the NSAC-202L R2 or R3 and a prediction model such as CHECWORKS. CHECWORKS does not provide assurance for meeting ASME acceptance criteria (for allowable minimum wall) – because these are outside the scope of CHECWORKS. The ASME Code Case 597-2 provides requirements applicable to non-planar flaws of the type resulting from FAC; these requirements are for Classes 1, 2, and 3 piping elements, as given in Section 3220 of the Code Case, which is in addition to the acceptance standards of the Construction Code of record. This Code Case has received conditional acceptance by the NRC; alternative	The acceptance criteria are independent of, and in addition to, the predictive method or the inspection results used as input to the predictive method. Guidance on more specific and well qualified acceptance criteria needs to be developed, confirmed (validated), and included in the AMP.	Review and include the needed guidance for acceptance criteria, independent of any predictive method.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
requirements must be supplemented in order to provide an acceptable level of quality and safety. The Code Case itself indicates in Section 3223 that the acceptance by engineering evaluation for Class 1 piping shall be conducted with methods and criteria developed by the Owner. The supplemental requirement for Class 1 piping not meeting the criteria by inspection is that the use of evaluation methods and criteria is subject to NRC review and approval per 10 CFR 50.55a(a)(3). In addition, in Section 3500(5)(b), the Code Case indicates that the acceptance criteria for Class 1, 2, and 3 pumps, valves, flanges, reducing elbows, socket and weld fittings, and any other piping items not covered by Section 3500(a) are the responsibility of the Owner.		
6.2: The FAC relevant safety-related portions of various reactor coolant and balance-of-plant systems are required to meet seismic criteria, design quality assurance of 10 CFR 50 Appendix B, as well as the ISI and in service testing (IST) under 10 CFR 50.55a(q), ASME Code Section XI, in addition to the applicable Codes and Standards for the original design and fabrication. The quality assurance of 10 CFR 50 Appendix B requires that the acceptance criteria be verified with independent testing and/or theory and analysis.	Over the period of extended operation, if the seismic criteria, or inputs to the seismic analysis are updated, or if the transient definitions change, then the basis for estimating allowable minimum wall thickness is likely to be affected. The acceptance criteria for FAC AMP should reflect this possibility.	Review and include the needed guidance for acceptance criteria, independent of any predictive method.
7. Corrective Actions		
Prior to service, components for which the acceptance criteria are not satisfied are reevaluated, repaired, or replaced. Long-term corrective actions could include adjusting operating parameters or selecting materials resistant to FAC. When susceptible components are replaced with resistant materials, such as high Cr material, the downstream components should be monitored closely to mitigate any increased wear. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Wall-thinning problems in single-phase systems have occurred in feedwater and condensate systems (NRC IE Bulletin No. 87-01; NRC Information Notice [IN] 81-28, IN 92-35, IN 95-11, IN 2006-08) and in two-phase piping in extraction steam lines (NRC IN 89-53, IN 97-84) and moisture separation reheater and feedwater heater drains (NRC IN 89-53, IN 91-18, IN 93-21, IN 97-84). Observed wall thinning may be due to mechanisms other than FAC, which require alternate materials to resolve the issue (Licensee Event Report 50-237/2007-003-00). Operating experience shows that the present program, when properly implemented, is effective in managing FAC in high-energy carbon steel piping and components.		
10.1: (From the plant-specific OE) Based on the NMP-1's chronological list of condition reports (CRs) just for the latest two years (2010–2011), there appear to be several instances of rejectable FAC indications, UT thickness readings below design basis or min-wall, excessive thinning, and non-conforming conditions for FAC. For a mature condition-monitoring program it is unclear whether such continued instances reflect systemic under-prediction in the methodology or an uncaptured increase in FAC susceptibility (or both).	The expectation from incorporation of improved methods and industry experience over a long period in the FAC management is that frequency and severity of FAC incidence will be reduced with time. This should be confirmed at the individual plant level through the program self-assessment.	Include self-assessment and identification of reasons if long-term strategy is not meeting performance goals from OE.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR Part 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Generic Letter 89-08, *Erosion/Corrosion-Induced Pipe Wall Thinning*, U.S. Nuclear Regulatory Commission, May 2, 1989.

NRC Inspection and Enforcement Bulletin 87-01, *Thinning of Pipe Walls in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, July 9, 1987.

NRC Information Notice 89-53, *Rupture of Extraction Steam Line on High Pressure Turbine*, U.S. Nuclear Regulatory Commission, June 13, 1989.

NRC Information Notice 91-18, *High-Energy Piping Failures Caused by Wall Thinning*, U.S. Nuclear Regulatory Commission, March 12, 1991.

NRC Information Notice 91-18, Supplement 1, *High-Energy Piping Failures Caused by Wall Thinning*, U.S. Nuclear Regulatory Commission, December 18, 1991.

NRC Information Notice 92-35, *Higher than Predicted Erosion/Corrosion in Unisolable Reactor Coolant Pressure Boundary Piping inside Containment at a Boiling Water Reactor*, U.S. Nuclear Regulatory Commission, May 6, 1992.

NRC Information Notice 93-21, *Summary of NRC Staff Observations Compiled during Engineering Audits or Inspections of Licensee Erosion/Corrosion Programs*, U.S. Nuclear Regulatory Commission, March 25, 1993.

NRC Information Notice 95-11, *Failure of Condensate Piping Because of Erosion/Corrosion at a Flow Straightening Device*, U.S. Nuclear Regulatory Commission, February 24, 1995.

NRC Information Notice 97-84, *Rupture in Extraction Steam Piping as a Result of Flow- Accelerated Corrosion*, U.S. Nuclear Regulatory Commission, December 11, 1997.

NRC Information Notice 99-19, *Rupture of the Shell Side of a Feedwater Heater at the Point Beach Nuclear Plant*, U.S. Nuclear Regulatory Commission, June 23, 1999.

NSAC-202L-R2, *Recommendations for an Effective Flow Accelerated Corrosion Program*, Electric Power Research Institute, Nuclear Safety Analysis Center, Palo Alto, CA, April 8, 1999.

NSAC-202L-R3, *Recommendations for an Effective Flow Accelerated Corrosion Program*, (1011838), Electric Power Research Institute, Nuclear Safety Analysis Center, Palo Alto, CA, May 2006.

NUREG-1344, *Erosion/Corrosion-Induced Pipe Wall Thinning in U.S. Nuclear Power Plants*, P. C. Wu, U.S. Nuclear Regulatory Commission, April 1989.

NRC Information Notice 2006-08, *Secondary Piping Rupture at the Mihama Power Station in Japan*, U.S. Nuclear Regulatory Commission, March 16, 2006.

NRC Licensee Event Report 50- 237/2007- 003- 00, *Unit 2 High Pressure Coolant Injection System Declared Inoperable*, U.S. Nuclear Regulatory Commission, September 24, 2007.

NRC Licensee Event Report 1999-003-01, *Manual Reactor Trip due to Heater Drain System Pipe Rupture Caused by Flow Accelerated Corrosion*, U.S. Nuclear Regulatory Commission, May 1, 2000.

Additional Reference

EPRI TR-106611-R1, *Flow-Accelerated Corrosion in Power Plants*, Electric Power Research Institute, Palo Alto, CA, August 1998.

A.17 XI.M18 Bolting Integrity

The verbatim text of GALL, Rev. 2, AMP XI.M18, Bolting Integrity, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program manages aging of closure bolting for pressure retaining components. The program relies on recommendations for a comprehensive bolting integrity program, as delineated in NUREG-1339, and industry recommendations, as delineated in the following documents: • NUREG-1339, "Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants." • Electric Power Research Institute (EPRI) NP-5769, "Degradation and Failure of Bolting in Nuclear Power Plants" (with the exceptions noted in NUREG-1339 for safety-related bolting). • EPRI TR-104213, "Bolted Joint Maintenance and Application Guide." The program generally includes periodic inspection of closure bolting for indication of loss of preload, cracking, and loss of material due to corrosion, rust, etc. The program also includes preventive measures to preclude or minimize loss of preload and cracking. Aging management program (AMP) XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," includes inspection of safety-related and non-safety-related closure bolting and supplements this bolting integrity program. AMPs XI.S1, "ASME Section XI, Subsection IWE"; XI.S3, "ASME Section XI, Subsection IWF"; XI.S6, "Structures Monitoring"; XI.S7, "RG 1.127, "Inspection of Water-Control Structures Associated with Nuclear Power Plants"; and XI.M23, "Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems," manage inspection of safety-related and non-safety related structural bolting.		
a.1: (Ginna plant visit) The effectiveness of this AMP for long-term operation is dependent on the recognition that it is (i) maintenance-driven, (ii) inspection-based program and that it (iii) includes preventive measures. This trio of actions differs from most of the other programs often credited, which are primarily of the condition-monitoring type. For example, in the Ginna LRA for non-structural bolting these other programs are the ASME Section XI,	Exclusively crediting other programs that do not include or focus on all three maintenance, inspection, and prevention aspects (in addition to monitoring) is inconsistent with the GALL Bolting Integrity AMP and has the potential to reduce the effectiveness of this AMP as intended over long-term operation. In addition, the training and qualification of personnel	Revise the program description to address and emphasize the noted aspects significant to

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Subsections IWB, IWC, and IWD Inservice Inspection, the Periodic Surveillance and Preventive Maintenance, the Boric Acid Corrosion, and the Systems Monitoring programs, to the exclusion of activities intended under this bolting integrity AMP.	involved (who may change from time to time) is significant to the long-term effectiveness of this AMP.	this AMP.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of its program description the basis documents NUREG-1339, EPRI NP-5769, and EPRI TR-104213.		
b.1: Several applicants in the past have used other (EPRI) documents, some not in the public domain, as the AMP basis instead of the GALL Report basis documents. This adds to the uncertainty about consistency and effectiveness of program implementation, especially if the documents used are much older (e.g., EPRI NP-5067) than those recommended as the basis (in GALL AMP). In addition, the industry-recommended guidance has changed as the bolting practices and experience have evolved, so the various basis documents listed have remnant contradictions (as indicated in a study by EPRI's Nuclear Maintenance Applications Center).	If the basis documents, especially as provided by the industry and the regulatory body, are substituted, then consistency with GALL, uniformity of implementation, and confirming effectiveness of the AMP require additional and unnecessary effort. The EPRI NMAC study has reconciled and consolidated the various earlier EPRI/industry guidelines documents into two EPRI reports (1015336 and 1015337). The oldest two-volume EPRI NP-5067 report has been removed from normal access (archived only for reference) and the EPRI TR-104213 has been replaced with the new guidance documents.	Confirm and replace the EPRI basis documents with the latest, consolidated guidance from EPRI. Strongly recommend adherence to uniform basis.
b.2: A general statement (in an LRA) that the bolting integrity program uses basis documents of this GALL AMP is inadequate for (judging) effectiveness, especially when numerous other AMPs are credited for the bolting integrity.	It is of relevance to the implementation and effectiveness of this AMP to clearly identify (in the LRA) which basis documents are used under which related or supplemental AMPs, and how this is done to meet the bolting integrity program activities.	Revise AMP description to reflect this need.
Program Consistency and Commitments		
This AMP at Ginna is based on Rev. 0 of the GALL report (2001), and neither the LRA nor the related SER (for Ginna) cite any exceptions with the GALL AMP, and do not include any enhancements or commitments associated with this AMP. However, it was noted that Ginna program basis document has identified that the related Structures Monitoring Program was not consistent with the GALL AMP, in that additional tests for detecting degradation of structural bolting and fasteners were not planned unless specifically required as a result of a		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
potentially degraded condition. The SER did not discuss or identify any issues relating to this inconsistency. The NMP-1 AMP is also based on Rev. 0 of the GALL report (2001) and, as noted in the LRA and associated SER, is consistent with an exception and enhancements, stated in Commitment #33 in Appendix A of the LRA for NMP-1.		
c.1: (Ginna plant visit) (As noted for Ginna, with similar adoptions likely at a few other plants) The program implementation has allowed the Bolting Integrity AMP to exclude any activities by itself, instead crediting activities performed under other AMPs for managing specific aging effects associated with bolting.	The AMP program description should be revised, if the bolting integrity program is to have independent standing, as it should, so that certain activities described in the program elements of this AMP are not excluded but are subject to implementation directly under this program, for the AMP to be effective.	Revise the program description to require direct coverage of intended activities under this AMP.
1. Scope of Program		
This program manages aging of closure bolting for pressure retaining components within the scope of license renewal, including both safety-related and non-safety-related bolting. This program does not manage aging of reactor head closure stud bolting (AMP XI.M3) or structural bolting (AMPs XI.S1, XI.S3, XI.S6, XI.S7, and XI.M23).		
1.1: The LRA should clearly indicate (tabulate) the bolting classification for all in-scope bolting covered under this AMP (i.e., whether safety related or non-safety related, whether in the ASME Section XI scope or outside of its scope and whether high strength or not). In addition, it should indicate which other AMPs are being credited to manage the aging effects of the so-classified bolting components. (Some of this classification may be adequate, if appropriate, at a system level.)	Actions under other program elements and the applicable basis documents of this AMP are dependent on the clarity of this classification; implementation and effectiveness of this AMP cannot be fully assessed otherwise. If only other AMPs are allowed or judged sufficient to manage bolting integrity, then the need for this as a separate AMP should be re-evaluated, or its scope appropriately defined and expanded.	Add to the scope the need for bolting classification, identifying applicable AMPs and basis used.
2. Preventive Actions		
Selection of bolting material and the use of lubricants and sealants is in accordance with the EPRI NP-5769 and the additional recommendations of NUREG-1339 to prevent or mitigate degradation and failure of safety-related bolting. NUREG-1339 takes exception to certain items in EPRI NP-5769 and recommends additional measures with regard to them. Of particular note, use of molybdenum disulfide (MoS2) as a lubricant has been shown to be a potential contributor to stress corrosion cracking (SCC) and should not be used. Preventive measures also include using bolting material that has an actual measured yield strength limited to less than 1,034		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
megapascals (MPa) (150 kilo-pounds per square inch [ksi]). Bolting replacement activities include proper torqueing of the bolts and checking for uniformity of the gasket compression after assembly. Maintenance practices require the application of an appropriate preload based on guidance in EPRI documents, manufacturer recommendations, or engineering evaluation.		
2.1: Specifying the use of multiple guidelines for preload likely results in non-uniformity and conflicting requirements. In addition, determination of actual preload and its monitoring have been problematic and often substituted to be managed by torqueing.	Better and more definitive guidance with regard to the preload requirements (its level and monitoring) is of significance to the aging effect management of bolting in long-term operation.	Review and revise the recommendations aspect.
3. Parameters Monitored/Inspected		
This program monitors the effects of aging on the intended function of bolting. Specifically, bolting for safety-related pressure retaining components is inspected for leakage, loss of material, cracking, and loss of preload/loss of prestress. Bolting for other pressure retaining components is inspected for signs of leakage. High strength closure bolting (actual yield strength greater than or equal to 1,034 MPa [150 ksi]), if used, should be monitored for cracking.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
The American Society of Mechanical Engineers (ASME) Section XI Inservice Inspection, Subsections IWB, IWC, and IWD program implements inspection of Class 1, Class 2, and Class 3 pressure retaining bolting in accordance with requirements of ASME Code Section XI, Tables IWB-2500-1, IWC-2500-1, and IWD-2500-1. These include volumetric and visual (VT-1) examinations, as appropriate. In addition, for both ASME Code class bolting and non-ASME Code class bolting, periodic system walkdowns and inspections (at least once per refueling cycle) ensure detection of leakage at bolted joints before the leakage becomes excessive. Bolting inspections should include consideration of the guidance applicable for pressure boundary bolting in NUREG-1339 and in EPRI NP-5769 and EPRI TR-104213. Degradation of pressure boundary closure bolting due to crack initiation, loss of preload, or loss of material may result in leakage from the mating surfaces or joint connections of pressure boundary components. Periodic inspection of pressure boundary components for signs of leakage ensures that age-related degradation of closure bolting is detected and corrected before component leakage becomes excessive. Accordingly, pressure retaining bolted connections should be inspected at least once per refueling cycle. The inspections may be performed as part of ASME Code Section XI leakage tests or as part of other periodic inspection activities, such as system walkdowns or an external surfaces monitoring program. High strength closure bolting (actual yield strength greater than or equal to 1,034 MPa (150 ksi) may be subject to stress corrosion cracking. For high strength closure bolts (regardless of code classification), volumetric examination in accordance to that of ASME Code Section XI, Table IWB-2500-1, Examination Category B-G-1, should be performed.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4.1: While the most recent (Rev. 2) GALL report adds a statement clarifying the volumetric examination requirement for all high-strength closure bolting, this was not clear in the previous versions used as basis in most existing plants. Furthermore, program implementation cannot be as effective unless the high-strength bolting has been fully identified (based on the actual yield strength); where such identification has not been rigorously performed, redundancy or other reasons are given leading to potentially inadequate examinations as needed.	Degradation of the high-strength closure bolting, particularly due to stress corrosion cracking that can remain undetected or may not necessarily lead to identifiable leak in timely manner, over longer terms of operation, has the potential for contributing to the loss of functionality. In addition, if a particularly susceptible heat of material was used in multiple bolting whose high-strength attribute remained unidentified, then multiple failures are likely to occur and reduce any effectiveness of the redundancy.	Add to the program element recommending that the high-strength bolting be identified, and provide guidance if not.
5. Monitoring and Trending		
The inspection schedules of ASME Section XI components are effective and ensure timely detection of applicable aging effects. If a bolting connection for pressure retaining components not covered by ASME Section XI is reported to be leaking, it may be inspected daily or in accordance with the corrective action process. If the leak rate is increasing, more frequent inspections may be warranted.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Any indications of aging effects in ASME pressure retaining bolting are evaluated in accordance with Section XI of the ASME Code. For other pressure retaining bolting, indications of aging should be dispositioned in accordance with the corrective action process.		
6.1: No further review item was identified.		
7. Corrective Actions		
Replacement of ASME pressure retaining bolting is performed in accordance with appropriate requirements of Section XI of the ASME Code, as subject to the additional guidelines and recommendations of EPRI NP-5769. Replacement of other pressure retaining bolting (i.e., non-ASME code class bolting) is performed in accordance with the guidelines and recommendations of EPRI TR-104213. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Degradation of threaded bolting and fasteners in closures for the reactor coolant pressure boundary has occurred from boric acid corrosion, SCC, and fatigue loading (U.S. Nuclear Regulatory Commission [NRC] IE Bulletin 82-02, NRC Generic Letter 91-17). SCC has occurred in high strength bolts used for nuclear steam supply system component supports (EPRI NP-5769). The bolting integrity program developed and implemented in accordance with the applicant's docketed responses to NRC communications on bolting events have provided an effective means of ensuring bolting reliability. These programs are documented in EPRI NP-5769 and TR-104213 and represent industry consensus. Degradation related failures have occurred in downcomer Tee-quencher bolting in boiling water reactors (BWRs) designed with drywells (ADAMS Accession Number ML050730347). Leakage from bolted connections has been observed in reactor building closed cooling systems of BWRs (LER 50-341/2005-001). The applicant is to evaluate applicable operating experience to support the conclusion that the effects of aging are adequately managed.		
10.1: (Ginna and NMP-1 plant visits) The OE on bolting related activity shows that the overall effectiveness of this AMP is quite plant-specific and is considerably impacted by the personnel training (qualification) and maintenance practices followed. Repeat instances of bolting related reports or corrective actions are also indicative of the need for improvements and self-assessment of plant-specific implementation of this AMP. (This includes, for example, the continued incidence of identified boric acid leakage at Ginna, and several instances of missing or loose bolting, cracked or damaged	Over time, the evolution of the frequency and number of locations of identified leakages should not be growing for the program to be demonstrably effective. For this maintenance-driven and inspection-based program, it would be relevant, therefore, to include as part of the AMP guidance a periodic review confirming the reduction of bolting related events and, depending on the review findings, requiring appropriate corrections or adjustments to the program through better training, tools, or practices.	Include specific recommendations for program self-assessment and adjustments.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
fasteners, and wrong or over torqued bolting at NMP-1 in the recent past, for a mature program. Audits at other plants also showed several instances of loose bolting connections, with loss of preload/stress relaxation, leading to support slippage, valve body leakage, and a damaged gasket, in the recent OE. While these may not directly reflect on any aging effect, per se, the continued instances reflect on the quality and adequacy of the bolting procedures or implementation.)		
10.2: A recent (October 2011) Supplemental Inspection 05000455/2011016 was performed by the staff to examine the causes for, and actions taken related to, a finding having low to moderate safety significance (i.e., White) at Byron Station, Unit 2. The finding (from NRC Inspection Report 05000455/2011011) involved the failure to ensure that a flange connection on the upper lube oil cooler of the 2A Emergency Diesel Generator (EDG) was correctly torqued following maintenance, leading to shutdown of the 2A EDG when a significant oil leak developed (during routine monthly surveillance testing). This recent supplemental inspection also revealed an adverse trend in maintenance rework issues centered on poor mechanical maintenance practices, including several examples resulting in bolted connection leakage.	The root cause was that there was no formal structured process in place to ensure that EPRI bolting guidance documents were actually reviewed to capture good work practices. Inadequate procedural direction on the assembly of multiple joint configurations was noted as the contributing cause.	As above.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volumes 1 and 2, Electric Power Research Institute, April 1988.

EPRI TR-104213, *Bolted Joint Maintenance & Application Guide*, Electric Power Research Institute, December 1995.

NRC Generic Letter 91-17, Generic Safety Issue 29, *Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, October 17, 1991.

NRC Inspection and Enforcement Bulletin No. 82-02, *Degradation of Threaded Fasteners in the Reactor Coolant Pressure Boundary of PWR Plants*, U.S. Nuclear Regulatory Commission, June 2, 1982.

NRC Morning Report, *Failure of Safety/Relief Valve Tee-Quencher Support Bolts*, March 14, 2005. (ADAMS Accession Number ML050730347)

NUREG-1339, Resolution of Generic Safety Issue 29: *Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, June 1990.

A.18 XI.M19 Steam Generator

The verbatim text of GALL, Rev. 2, AMP XI.M19, Steam Generators, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to Ginna plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The Steam Generator program is applicable to managing the aging of steam generator tubes, plugs, sleeves, and secondary side components that are contained within the steam generator (i.e., secondary side internals). The establishment of a steam generator program for ensuring steam generator tube integrity is required by plant technical specifications. The steam generator tube integrity portion of the technical specifications at each PWR contains the same fundamental requirements as outlined in the standard technical specifications of NUREG-1430, Volume 1, Rev. 3, for Babcock & Wilcox pressurized water reactors (PWRs); NUREG-1431, Volume 1, Rev. 3, for Westinghouse PWRs; and NUREG-1432, Volume 1, Rev. 3, for Combustion Engineering PWRs. The requirements pertaining to steam generators in these three versions of the standard technical specifications are essentially identical. The technical specifications require tube integrity to be maintained and specify performance criteria, condition monitoring requirements, inspection scope and frequency, acceptance criteria for the plugging or repair of flawed tubes, acceptable tube repair methods, and leakage monitoring requirements. The nondestructive examination techniques used to inspect tubes, plugs, sleeves, and secondary side internals are intended to identify components (e.g., tubes, plugs) with degradation that may need to be removed from service or repaired. The Steam Generator program at PWRs is modeled after Nuclear Energy Institute (NEI) 97-06, Revision 2, “Steam Generator Program Guidelines.” This program references a number of industry guidelines (e.g., the EPRI PWR Steam Generator Examination Guidelines, PWR Primary-to-Secondary Leak Guidelines, PWR Primary Water Chemistry Guidelines, PWR Secondary Water Chemistry Guidelines, Steam Generator Integrity Assessment Guidelines, Steam Generator In Situ Pressure Test Guidelines) and incorporates a balance of prevention, mitigation, inspection, evaluation, repair, and leakage monitoring measures. The NEI 97-06 document (a) includes performance criteria that are intended to provide assurance that tube integrity is being maintained consistent with the plant’s licensing basis and (b) provides guidance for monitoring and maintaining the tubes to provide assurance that the performance criteria are met at all times between scheduled inspections of the tubes. Steam generator tube integrity can be affected by degradation of steam generator plugs, sleeves, and secondary side internals. Therefore, all of these components are addressed by this aging management program (AMP). The NEI 97-06 program has been effective at managing the aging effects associated with steam generator tubes, plugs, sleeves, and secondary side internals.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.1: See items discussed under various program elements below.	See items discussed under various program elements below.	Revise and/or expand.
Program Basis Documents and/or Supporting Documents		
As part of its program description, the GALL, Rev. 2, AMP includes NEI 97-06 Rev. 2 as the primary basis document, referencing other guidelines.		
b.1: It should be noted that the primary documents covering the technical basis (in NEI 97-06) are the various EPRI guidelines referenced in NEI 97-06. Even at the time Rev. 2 of NEI 97-06 was issued (September 2005), these documents were regarded as "open" references (i.e., work in progress). These documents have undergone, and continue to undergo, revisions that need to be identified and updated as part of the AMP.	The revised basis documents incorporate more recent experience, enhancements, and research findings of significance to the effective implementation of NEI 97-06 guidelines for the steam generator AMP.	Revise the program description to reflect the importance of revisions to follow.
b.2: Rev. 2 of the GALL report NUREG-1801 references an older basis document "EPRI 1012987, Steam Generator Integrity Assessment Guidelines: Rev. 2, July 2006."	"EPRI 1019038, Steam Generator Management Program: Steam Generator Integrity Assessment Guidelines, Rev. 3, Nov. 2009," was the document whose guidelines were in effect at the time NUREG-1801, Rev. 2, was issued.	Correct the identified reference.
b.3: The current industry guidelines, dated January 2011, are in Revision 3 of NEI 97-06, Jan. 2011.	The changes in Rev. 3 of NEI 97-06 include (a) removal of "requirements" in NEI 97-06 that are located in other industry documents (e.g., NEI 03-08 and the EPRI guidelines referenced in NEI 97-06), (b) corrections to definitions, and (c) corrections for inconsistencies with requirements in the technical specifications. These are significant changes for AMP implementation.	Revise the AMP description and references to the updated documents.
Program Consistency and Commitments		
This AMP at Ginna is based on Rev. 0 of the GALL report (2001), and the SER for the Ginna LRA showed the AMP to be consistent with 2001 GALL Report, with exceptions but no enhancements or commitments.		
c.1: (Ginna plant visit) The steam generator (SG) procedures have statements indicating exemptions from 10 CFR Part 50.59 requirements.	The license renewal guidance documents may need to further clarify that the aging management programs and activities summarized in the UFSAR are subject to the	Add relevant clarification to LR guidance

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	requirements of 10 CFR 50.59.	documents.
1. Scope of Program		
This program addresses degradation associated with steam generator tubes, plugs, sleeves, and secondary side components that are contained within the steam generator (i.e., secondary side internals). It does not cover degradation associated with the steam generator shell, channel head, nozzles, or welds associated with these components.		
1.1: The nickel-based (cladded) divider plate/tubesheet, associated welds/HAZ, and welded tube-ends are susceptible to PWSCC, and these are SG internal components needed in maintaining SG functionality and the leakage barrier. Aging-related activities of detection and management of this PWSCC do not appear to be well recognized or formally included in the Steam Generator AMP implementation.	The confirmed PWSCC in the noted areas of the SGs, at least under certain conditions of fabrication and design, has the potential to be generic during the PEO. It is relevant to at least include this in the scope of this AMP and have detection and inspection recommendations on it.	Revise the AMP program elements of scope, detection, and parameters inspected.
2. Preventive Actions		
This program includes preventive and mitigative actions for addressing degradation. Preventive and mitigative measures that are part of the Steam Generator program include foreign material exclusion programs, and other primary and secondary side maintenance activities. The program includes foreign material exclusion as a means to inhibit wear degradation and secondary side maintenance activities, such as sludge lancing, for removing deposits that may contribute to degradation. Guidance on foreign material exclusion is provided in NEI 97-06. Guidance on maintenance of secondary side integrity is provided in the EPRI Steam Generator Integrity Assessment Guidelines. Primary side preventive maintenance activities include replacing plugs made with corrosion susceptible materials with more corrosion resistant materials and preventively plugging tubes susceptible to degradation. Extensive deposit buildup in the steam generators could affect tube integrity. The EPRI Steam Generator Integrity Assessment Guidelines, which are referenced in NEI 97-06, provide guidance on maintenance on the secondary side of the steam generator, including secondary side cleaning. Secondary side water chemistry plays an important role in controlling the introduction of impurities into the steam generator and potentially limiting their deposition on the tubes. Maintaining high water purity reduces susceptibility to SCC or IGSCC. Water chemistry is monitored and maintained in accordance with the Water Chemistry program. The program description and evaluation and technical basis of monitoring and maintaining water chemistry are addressed in GALL AMP XI.M2, “Water Chemistry.”		
2.1: Foreign objects left in service have caused degradation of tubes mostly on the secondary side, although some primary side damage has been noted leading to PWSCC on the divider plate. Plants (e.g. Ginna) using older	It seems relevant that a broader and explicit program of preventive action(s) and formal evaluation of foreign object(s) on secondary and primary side be included as part of this AMP.	Revise the program element to expand the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
revisions of GALL Report may not formally include the foreign material exclusion (FME) program noted in Rev. 2 of the GALL report, as part of the SG aging management program. In addition, NEI 97-06 (Rev. 2), May 2005, indicated the use of EPRI SG Examination Guidelines for this activity is for recording any evaluation(s) and not for the evaluation itself, unless updated guidelines address and are implemented to do the evaluation of foreign objects–related degradation.		actions needed for managing aging effects of foreign objects in the SGs.
3. Parameters Monitored/Inspected		
There are currently three types of steam generator tubing used in the United States: mill annealed Alloy 600, thermally treated Alloy 600, and thermally treated Alloy 690. Mill annealed Alloy 600 steam generator tubes have experienced degradation due to corrosion (e.g., primary water stress corrosion cracking, outside diameter stress corrosion cracking, intergranular attack, pitting, and wastage) and mechanically induced phenomena (e.g., denting, wear, impingement damage, and fatigue). Thermally treated Alloy 600 steam generator tubes have experienced degradation due to corrosion (primarily cracking) and mechanically induced phenomena (primarily wear). Thermally treated Alloy 690 tubes have only experienced tube degradation due to mechanically induced phenomena (primarily wear). Degradation of tube plugs, sleeves, and secondary side internals have also been observed, depending, in part, on the material of construction of the specific component. The program includes an assessment of the forms of degradation to which a component is susceptible and implementation of inspection techniques capable of detecting those forms of degradation. The parameter monitored is specific to the component and the acceptance criteria for the inspection. For example, the severity of tube degradation may be evaluated in terms of the depth of degradation or measured voltage, dependent on whether a depth-based or voltage-based tube repair criteria (acceptance criteria) is being implemented for that specific degradation mechanism. Other parameters monitored include signals of excessive deposit buildup (e.g., steam generator water level oscillations), which may result in fatigue failure of tubes or corrosion of the tubes; water chemistry parameters, which may indicate unacceptable levels of impurities; primary-to-secondary leakage, which may indicate excessive tube, plug, or sleeve degradation; and the presence of loose parts or foreign objects on the primary and secondary side of the steam generator, which may result in tube damage. Water chemistry parameters are also monitored as discussed in AMP XI.M2. The EPRI PWR Steam Generator Primary-to-Secondary Leakage Guidelines (EPRI 1008219) provides guidance on monitoring primary-to-secondary leakage. The EPRI Steam Generator Integrity Assessment Guidelines (EPRI 1012987) provide guidance on secondary side activities. In summary, the NEI 97-06 program provides guidance on parameters to be monitored or inspected.		
3.1: Virtually all PWRs will enter the period of extended	The inspection and condition monitoring requirements of	Add to the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
operation with replacement steam generators having thermally treated (TT) Alloy 690 tubes, although a few may have Alloy 600 TT tubes. Program Element 3 ("Parameters Monitored/Inspected") notes that Alloy 690 TT tubes have only experienced tube degradation due to mechanically induced phenomena (primarily wear) and have not been subject to primary water SCC or outer-diameter SCC. However, there is no assurance that Alloy 690 TT tubes will continue to be free from SCC during the period of extended operation. This is particularly true for off-normal chemistry incursions (with sulphur- or lead-bearing components) and for the secondary side chemistry/crevice conditions.	AMP XI.M19 should remain in full force during the period of extended operation despite the apparent increased resistance of Alloy 690 TT steam generator tubes to SCC.	description that the off-normal chemistry parameters should be monitored and assessed periodically.
4. Detection of Aging Effects		
The technical specifications require that a Steam Generator program be established and implemented to ensure that steam generator tube integrity is maintained. This requirement ensures that components that could compromise tube integrity are properly evaluated or monitored (e.g., degradation of a secondary side component that could result in a loss of tube integrity is managed by this program). The inspection requirements in the technical specifications are intended to detect degradation (i.e., aging effects), if they should occur. The technical specifications are performance-based, and the actual scope of the inspection and the expansion of sample inspections are justified based on the results of the inspections. The goal is to perform inspections at a frequency sufficient to provide reasonable assurance of steam generator tube integrity for the period of time between inspections. The general condition of some components (e.g., plugs and secondary side components) may be monitored visually, and, subsequently, more detailed inspections may be performed if degradation is detected. NEI 97-06 provides additional guidance on inspection programs to detect degradation of tubes, sleeves, plugs, and secondary side internals. The frequencies of the inspections are based on technical assessments. Guidance on performing these technical assessments is contained in NEI 97-06 and the associated industry guidelines. The inspections and monitoring are performed by qualified personnel using qualified techniques in accordance with approved licensee procedures. The EPRI PWR Steam Generator Examination Guidelines (EPRI 1013706) contains guidance on the qualification of steam generator tube inspection techniques. The primary-to-secondary leakage monitoring program provides a potential indicator of a loss of steam generator tube integrity. NEI 97-06 and the associated EPRI guidelines provide information pertaining to an effective leakage monitoring program.		
4.1: In this program element, the absence of formal	More direct and notable coverage of detecting and	Expand the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
inclusion and discussion of effective means of detection of degradation in the (cladded) tubesheet, divide plate, tube-ends, and associated weld (HAZ) locations are of concern. There is no well-qualified eddy current inspection technique at present for these welds, adding inspectability concerns to the associated potential PWSCC issue.	managing the aging effects of stated locations during the period of extended operation should add to the effective implementation of this AMP. For instance, Incoloy 82 cladding on the tubesheet is susceptible to PWSCC and this susceptibility may extend into the autogeneous tube-to-tubesheet welds due to dilution of the Alloy 690 tubing material with the Inconel 82.	program element description.
5. Monitoring and Trending		
Condition monitoring assessments are performed to determine whether the structural- and accident-induced leakage performance criteria were satisfied during the prior operating interval. Operational assessments are performed to verify that structural and leakage integrity will be maintained for the planned operating interval before the next inspection. If tube integrity cannot be maintained for the planned operating interval before the next inspection, corrective actions are taken in accordance with the plant's corrective action program. Comparisons of the results of the condition monitoring assessment to the predictions of the previous operational assessment are performed to evaluate the adequacy of the previous operational assessment methodology. If the operational assessment was not conservative in terms of the number and/or severity of the condition, corrective actions are taken in accordance with the plant's corrective action program. The technical specifications require condition monitoring and operational assessments to be performed (although the technical specifications do not explicitly require operational assessments, these assessments are necessary to ensure that the tube integrity will be maintained until the next inspection). Condition monitoring and operational assessments are done in accordance with the technical specification requirements and guidance in NEI 97-06 and the EPRI Steam Generator Integrity Assessment Guidelines. The goal of the inspection program for all components covered by this AMP is to ensure that the components continue to function consistent with the design and licensing basis of the facility (including regulatory safety margins). Assessments of the degradation of steam generator secondary side internals are performed in accordance with the guidance in the EPRI Steam Generator Integrity Assessment Guidelines to ensure the component continues to function consistent with the design and licensing basis and to ensure technical specification requirements are satisfied.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
Assessment of tube and sleeve integrity and plugging or repair criteria of flawed and sleeved tubes is in accordance with plant technical specifications. The criteria for plugging or repairing steam generator tubes and sleeves are based on U.S. Nuclear Regulatory		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Commission (NRC) Regulatory Guide 1.121 and are incorporated into plant technical specifications. Guidance on assessing the acceptability of flaws is also provided in NEI 97-06 and the associated EPRI guidelines, including the EPRI Steam Generator In-Situ Pressure Test Guidelines and EPRI Steam Generator Integrity Assessment Guidelines. Degraded plugs, degraded secondary side internals, and leaving a loose part or a foreign object in the steam generator are evaluated for continued acceptability on a case-by-case basis. NEI 97-06 and the associated EPRI guidelines provide guidance on the performance of these evaluations. The intent of these evaluations is to ensure that the components affected by parts or objects have adequate integrity consistent with the design and licensing basis of the facility. Guidance on the acceptability of primary-to-secondary leakage and water chemistry parameters also are discussed in NEI 97-06 and the associated EPRI guidelines.		
6.1: Acceptance criteria, in the general context of this AMP, also refer to meeting the various performance criteria described in the basis documents. It is not clear from the description of this program element that any failure to meet a performance criterion means that degradation of a safety barrier has occurred, such that the reporting requirements of §50.72 and §50.73 are applicable.	SG tube integrity related technical specifications require (presume) compliance with the SG performance criteria.	Add clarification on performance criteria vis-à-vis acceptance criteria, and the related requirements.
7. Corrective Actions		
For degradation of steam generator tubes and sleeves (if applicable), the technical specifications provide requirements on the actions to be taken when the acceptance criteria are not met. For degradation of other components, the appropriate corrective action is evaluated per NEI 97-06 and the associated EPRI guidelines, the American Society of Mechanical Engineers (ASME) Code Section XI (2004 Edition), 10 CFR 50.65, and 10 CFR Part 50, Appendix B, as appropriate. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable for ensuring effective corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
Site quality assurance (QA) procedures, review and approval processes, and site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
confirmation process and administrative controls. In addition, the adequacy of the preventive measures in the Steam Generator program is confirmed through periodic inspections.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Several generic communications have been issued by the NRC related to the steam generator programs implemented at plants. The reference section lists many of these generic communications. In addition, NEI 97-06 provides guidance to the industry for routinely sharing pertinent steam generator operating experience and for incorporating lessons learned from plant operation into guidelines referenced in NEI 97-06. The latter includes providing interim guidance to the industry, when needed. The NEI 97-06 program has been effective at managing the aging effects associated with steam generator tubes, plugs, sleeves, and secondary side components that are contained within the steam generator (i.e., secondary side internals), such that the steam generators can perform their intended safety function.		
10.1: (Ginna plant visit) While tube denting is not a new degradation mechanism, its reappearance (e.g., Ginna experience) and potential consequences for tubing SCC/IGA, even with Alloy 690, due to potential for high stressing conditions, and in combination with possible caustic conditions if enough sludge accumulation/hardening is allowed to remain, is of concern.	Over long-term operation, undetected or uncorrected tube denting has significant ramifications for tube integrity and any inspection interval(s) based on the assumption of its non-occurrence.	Review the potential for conditions likely to result in denting and add preventive measures or evaluations needed.
10.2: (Ginna plant visit) Primary side fouling within SG was noted in Ginna program description and a few other LRAs in the past. These instances were noted either because of	Primary side fouling does not appear to be confirmed as an aging effect to be covered in this AMP.	None.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
use of an older generic GALL template or misunderstanding of GALL requirements (as concluded in TSTF-510 update – ML110490077).		

References

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10 CFR Part 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.65, *Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI 1008219, *PWR Primary-to-Secondary Leak Guidelines*: Revision 3, Electric Power Research Institute, Palo Alto, CA, December 2004.

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NRC Generic Letter 97-05, *Steam Generator Tube Inspection Techniques*, U.S. Nuclear Regulatory Commission, December 17, 1997.

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NRC Information Notice 2005-09, *Indications in Thermally Treated Alloy 600 Steam Generator Tubes and Tube-to-Tubesheet Welds*, U.S. Nuclear Regulatory Commission, April 7, 2005.

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A.19 XI.M20 Open Cycle Cooling Water System

The verbatim text of GALL, Rev. 2, AMP XI.M20, Open Cycle Cooling Water System, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program relies on implementation of the recommendations of the NRC GL 89-13 to ensure that the effects of aging on the open cycle cooling water (OCCW) (or service water) system will be managed for the period of extended operation. NRC GL 89-13 defines the OCCW system as a system or systems that transfer heat from safety-related structures, systems, and components (SSCs) to the ultimate heat sink (UHS). The guidelines of NRC GL 89-13 for managing an OCCW include (a) surveillance and control of biofouling (see Chapter IX of NUREG-1801); (b) a test program to verify heat transfer capabilities; (c) routine inspection and a maintenance program to ensure that corrosion, erosion, protective coating failure, sediment deposition (silting), and biofouling cannot degrade the performance of safety-related systems serviced by OCCW; (d) a system walkdown inspection to ensure compliance with the licensing basis; and (e) a review of maintenance, operating, and training practices and procedures. In accordance with guidance of NRC GL 89-13, the OCCW aging management program manages aging effects of components in raw water systems, such as the service water or river water, by using a combination of preventive, condition, and performance monitoring activities. These include (a) surveillance and control techniques to manage aging effects caused by biofouling, corrosion, erosion, protective coating failures, and silting in the OCCW system or structures and components serviced by the OCCW system; (b) inspection of critical components for signs of corrosion, erosion, and biofouling; and (c) testing of the heat transfer capability of heat exchangers that remove heat from components important to safety. For buried OCCW piping, the aging effects on the external surfaces are managed by XI.M41, but the internal surfaces are managed by this program. The aging management of closed-cycle cooling water (CCCW) systems is described in XI.M21A, “Closed Treated Water Systems,” and is not included as part of this program. The OCCW System program applies to components constructed of various materials, including steel, stainless steel, aluminum, copper alloys, titanium, polymeric materials, and concrete. Piping may be lined with internal coatings or unlined.		
a.1: No specific concerns for LTO.		
Program Basis Documents and/or Supporting Documents		
As part of the program description, the GALL, Rev. 2, AMP includes guidance from NRC Generic Letter 89-13 and 10 CFR Part 50, Appendix B. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, and both the Ginna Service		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Water System Reliability and Optimization Program (B2.1.22) and the amended NMP-1 LRA Open Cycle Cooling Water System Program (B2.1.10) cite the same guidance.		
b.1: The guidance cited in GALL under GL 89-13 is subject to possible future updates.	Unless the program basis and supporting documents are current and complete, the applicant's AMP for LTO will not represent the best available guidance for aging management.	Verify that the guidance cited in the AMP for LTO is current and complete.
Program Consistency and Commitments		
The Ginna Service Water System Reliability and Optimization Program (B2.1.22) claims consistency with GALL with the following two exceptions: (1) heat transfer tests are not performed on selected small heat exchangers, which are periodically cleaned and inspected in accordance with the Ginna Periodic Surveillance and Preventive Maintenance Program; and (2) the Ginna AMP does not address protective coatings, which are not credited for aging management in the Ginna Service Water System. Both of these exceptions were found to be acceptable by the NRC after additional clarification. No commitments are identified. The NMP-1 amended LRA Open Cycle Cooling Water System Program (B2.1.10) takes no exceptions to GALL, but includes enhancements that are claimed to encompass revisions to existing activities that are credited for license renewal to ensure the applicable aging effects are discovered and evaluated. These enhancements and the impacted program elements are as follows: Element 1, Scope of Program: • Ensure that the applicable NMP-1 commitments made for GL 89-13, and the requirements in NUREG-1801, Section XI.M20, are captured in the NMP-1 implementing documents for GL 89-13. • Ensure that the applicable NMP-2 commitments made for GL 89-13, and the requirements in NUREG-1 801, Section XI.M20, are captured in N2-TDP-REL-0104, UGL 89-13, Service Water System Problems Affecting Safety Related Equipment Program Plan. • Where the requirements of the NUREG-1801, Section XI.M20 are more conservative than the GL 89-13 commitments, they will be incorporated into the OCCWS program. Element 6, Acceptance Criteria: • Revise the NMP-1 and NMP-2 preventive maintenance and heat transfer performance test procedures to incorporate specific inspection criteria, corrective actions, and frequencies. NMP-1 committed to implementing these enhancements prior to entering the period of extended operation, and the NRC found the enhanced Open Cycle Cooling Water System Program to be acceptable.		
c.1: No specific concerns for LTO.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1. Scope of Program		
The program addresses the aging effects of material loss and fouling due to micro- or macro-organisms and various corrosion mechanisms generally found in OCCW systems and OCCW steel piping components with or without protective coating as described in the applicant's response to NRC GL 89-13. OCCW systems, as defined by NRC GL 89-13, include the service water system and any other cooling system exposed to raw water that transfers heat from safety-related SSCs to the UHS. The OCCW System program applies to components constructed of various materials, including steel, stainless steel, aluminum, copper alloys, titanium, polymeric materials, and concrete. Piping may be lined with internal coatings or unlined.		
1.1: Copper-zinc (brass >15% Zn) alloys are commonly used in OCCW System heat exchangers as tubing materials. These alloys are susceptible to SCC in contact with component cooling water and service water at temperatures up to 38°C (100°F). The aggressive species in the water that could potentially produce SCC in brass components include ammonia, various amines, and chlorides.	GALL AMP XI.M20 makes no direct mention of SCC as a degradation mechanism, focusing instead on material loss and fouling. Operating experience at nuclear plant needs to be reviewed to determine if, in fact, SCC has occurred in OCCW brass heat exchanger tubes.	If SCC of brass heat exchanger tubes in the OCCW System is found to be a problem, AMP XI.M20 needs to be updated.
1.2: (Ginna plant visit) At Ginna, a problem was identified regarding piping internal roughness assumptions used in developing acceptance criteria for the safety-related auxiliary feedwater supply. This piping is used to introduce service water into the reactor system in a LOCA event. Due to the increased roughness from tubercles and other ongoing fouling mechanisms, the current acceptance criteria established for pressure requirements may not provide sufficient flow in the event of a LOCA.	It does not appear that this type of degradation mechanism had been considered in the design of the system or in establishing acceptance criteria, nor is it directly addressed in GALL AMP XI.M20. Since this configuration is not tested due to the adverse effects of introducing raw water into the steam generators, additional steps may need to be taken to address this aspect.	GALL AMP XI.M20 may require updating to address this aging process.
2. Preventive Actions		
Preventive actions begin with the use of appropriate material for construction. Steel piping system components are typically lined or coated to protect the underlying metal surfaces from exposure to corrosive cooling water environments. Implementation of NRC GL 89-13 includes control or preventive measures, such as chemical treatment whenever the potential for biological fouling exists or flushing of infrequently used systems. Treatment with chemicals mitigates microbiologically-influenced corrosion (MIC) and buildup of macroscopic biological fouling debris from biota, such as blue mussels,		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
oysters, or clams. Periodic flushing of the system removes accumulations of biofouling agents, corrosion products, and debris or silt.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
This program manages the aging effects, such as loss of heat transfer capability, loss of material, and corrosion effects. Adverse effects on system or component performance are caused by accumulations of biofouling agents, corrosion products, and silt. Cleanliness and material integrity of piping, components, heat exchangers, elastomers, and their internal linings or coatings (when applicable) that are part of the OCCW system or that are cooled by the OCCW system are periodically inspected, monitored, or tested to ensure their heat transfer capabilities. The program ensures (a) removal of accumulations of biofouling agents, corrosion products, and silt and (b) detection of defective protective coatings and corroded OCCW system piping and components that could adversely affect performance of their intended safety functions.		
3.1: (Ginna plant visit) GALL AMP XI.M20 is implemented at Ginna through its "Service Water System Reliability and Optimization Program" (B2.1.22). As stated in the LRA, this program takes exception to GALL guidance calling for the heat transfer tests on selected small heat exchangers in the OCCW system, relying instead on periodic cleaning and inspection.	Substantial portions of the internal surfaces of heat exchangers in the OCCW system are often inaccessible for periodic inspections, and heat transfer testing provides the only viable alternative for monitoring their condition. Where operating experience, particularly during the initial 20-year license extension period, indicates that periodic inspections alone are inadequate to maintain heat exchanger performance, heat transfer testing will be required.	Where indicated by OE, AMP XI.M20 may need to be revised to mandate heat transfer testing.
4. Detection of Aging Effects		
Inspection scope, methods (e.g., visual or nondestructive examination), and testing frequencies are in accordance with the applicant's docketed response to NRC GL 89-13. Inspections for biofouling, damaged coatings, and degraded material condition are conducted. Visual inspections are typically performed to determine whether corrosion, erosion, or biofouling are occurring in the system. Examinations of polymeric materials should be consistent with the examinations described in AMP XI.M38 Nondestructive testing, such as ultrasonic testing and eddy current testing, are effective methods to measure surface conditions or the extent of wall thinning associated with the service water system piping and components.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
Heat transfer testing results are documented in plant test procedures and are trended in accordance with the applicant's docketed response to NRC GL 89-13. If corrosion buildup or fouling is noted, the system also is evaluated for their impact on the heat transfer capability of the system. Evidence of corrosion in these systems also is evaluated for its potential impact on the integrity of the piping. For		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
relevant indications, inspections or nondestructive testing is used to determine the extent of biofouling, the condition of the surface coating, the magnitude of localized pitting, and the amount of MIC, if applicable.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
The acceptance criteria are in accordance with the applicant's docketed response to NRC GL 89-13. Corrosion, erosion, and biofouling can cause significant loss of material in components. Inspected components should exhibit adequate design margin regarding design dimensions (e.g., minimum required wall thickness). As applicable, coatings or linings should be intact to protect the underlying metal. Heat removal capability is within allowable values for the system and components tested, in accordance with NRC GL 89-13.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Evaluations are performed for test or inspection results that do not satisfy established acceptance criteria, and a problem or condition report is initiated to document the concern in accordance with plant administrative procedures. The corrective actions program ensures that the conditions adverse to quality are promptly corrected. If the deficiency is assessed to be significantly adverse to quality, the cause of the condition is determined, and an action plan is developed to preclude repetition. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Significant MIC (NRC Information Notice [IN] 85-30, IN 07-06), failure of protective coatings (NRC IN 85-24), and fouling (NRC IN 81-21, IN 86-96, IN 07- 04, IN 07-28) have been observed in a number of heat exchangers. The guidance of NRC GL 89-13 has been implemented for more than 20 years and has been effective in managing aging effects due to biofouling, corrosion, erosion, protective coating failures, and silting in structures and components serviced by OCCW systems.		
10.1: (Ginna plant visit) Operating experience at Ginna suggests that their AMP for managing aging in the OCCW system has been reasonably effective up to the present time. However, past performance is no guarantee of future results.	Operating experience at Ginna and other plants (see entry below) should continue to be monitored, particularly during the initial 20-year license extension period as the components continue to accumulate additional time in service. Should this operating experience indicate a clear increase in degradation problems in the OCCW system components, the guidance of GL 89-13 may require revision and updating.	Revise GL 89-13 guidance as necessary, based upon present and future operating experience.
10.2: (NMP-1 plant visit) The July–Sept. 2011 System Health Report for the Service Water System at NMP-1 notes that much of the piping is in “a generally degraded condition.” As a result, through-wall leaks occur at an “unacceptable” frequency of approximately one per year for 3-inch and smaller diameter piping. Furthermore, the frequency of leaks is increasing.	In contrast to the operating experience with the OCCW system at Ginna, the operating experience at NMP-1 has been relatively poor. This illustrates the importance of monitoring plant-specific operating experience. For plants with poor operating experience, it is desirable to verify their conformance to the guidance of GL 89-13. If, despite following this guidance, they have experienced significant problems, then the GL 89-13 guidance may require revision (see entry above). For plants where poor operating experience is the result of failure to follow GL 89-13 guidance, a detailed one-time inspection of the OCCW system and a review of procedures for implementing GL 89-13 guidance may be required prior to entering LTO.	For plants with poor operating experience, a detailed one-time inspection of the CCCW system and a review of procedures for implementing GL 89-13 guidance may be required prior to entering LTO.

References

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NRC Information Notice 2007-28, *Potential Common Cause Vulnerabilities in Essential Service Water Systems Due to Inadequate Chemistry Controls*, U.S. Nuclear Regulatory Commission, September 17, 2007.

NRC Information Notice 2007-06, *Potential Common Cause Vulnerabilities in Essential Service Water Systems*, U.S. Nuclear Regulatory Commission, February 9, 2007.

NUREG-1915, *Safety Evaluation Report Related to the License Renewal of Wolf Creek Generating Station*, U.S. Nuclear Regulatory Commission, October 2008.

A.20 XI.M21A Closed Treated Water System

The verbatim text of GALL, Rev. 2, AMP XI.M21A, Closed Treated Water System, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Nuclear power plants contain many closed, treated water systems. These systems undergo water treatment to control water chemistry and prevent corrosion (i.e., treated water systems). These systems are also recirculating systems in which the rate of recirculation is much higher than the rate of addition of makeup water (i.e., closed systems). The program includes (a) water treatment, including the use of corrosion inhibitors, to modify the chemical composition of the water such that the function of the equipment is maintained and such that the effects of corrosion are minimized; (b) chemical testing of the water to ensure that the water treatment program maintains the water chemistry within acceptable guidelines; and (c) inspections to determine the presence or extent of corrosion and/or cracking. Depending on the industry standard selected for use in association with this aging management program (AMP) and/or plant operating experience, this program also may include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing.		
a.1: No specific concerns for LTO.		
Program Basis Documents and/or Supporting Documents		
As part of the program description, the GALL, Rev. 2, AMP includes guidance from NRC Generic Letter 89-13; EPRI 1007820; and 10 CFR 50, Appendix B. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, and both the Ginna Closed-Cycle (Component) Cooling Water System Program (B2.1.8) and the NMP-1 Closed-Cycle Cooling Water System Program (B2.1.11) cite NRC GL 89-13; EPRI 107396; and 10 CFR 50, Appendix B.		
b.1: The EPRI guidance on CCCW chemistry cited in GALL is periodically updated, and the guidance under GL 89-13 is also subject to possible future updates.	Unless the program basis and supporting documents are current and complete, the applicant's AMP for LTO will not represent the best available guidance for aging management.	Verify that the guidance cited in the AMP for LTO is current and complete.
Program Consistency and Commitments		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The Ginna Closed-Cycle (Component) Cooling Water System Program (B2.1.8) makes an exception to GALL, Rev. 0, in that EPRI TR-107396 is not referenced in Ginna procedures, and the only parameters monitored are pH, corrosion inhibitor concentrations, and radioactivity. Ginna claimed in its LRA that plant operating experience has not demonstrated the need to monitor the additional parameters, such as corrosion products, calcium, potassium, or refrigerant chemicals, in the EPRI report. This exception was reviewed by NRC staff and, after additional information was provided, it was found to be acceptable. The NMP-1 Closed-Cycle Cooling Water System Program (B2.1.11) makes no exceptions to GALL, Rev. 0, but adds enhancements to encompass revisions to existing activities that are credited for license renewal to ensure the applicable aging effects are discovered and evaluated. These enhancements and the impacted program elements are as follows: <u>Program Element 2 (Preventive Actions)</u> • Expand periodic chemistry checks of CCCW Systems consistent with the EPRI TR-107396. • Implement a program to use corrosion inhibitors in the NMP-1 and NMP-2 Reactor Building Closed Loop Cooling Systems, NMP-1 Control Room HVAC System, and NMP-2 Control Building Ventilation Chilled Water System in accordance with the guidelines given in EPRI TR-107396. <u>Program Elements 3 and 4 (Parameters Monitored/Inspected, Detection of Aging Effects)</u> • Direct periodic inspections to monitor for loss of material in the piping of the CCCW systems. • Implement a corrosion monitoring program for larger bore CCCW piping not subject to inspection under another program at NMP-1. <u>Program Element 5 (Monitoring and Trending)</u> • Establish the frequencies to inspect for degradation of components in CCCW Systems, including heat exchanger tube wall thinning. • Perform a heat removal capability test for the NMP-1 Control Room HVAC System at least every 5 years. • Establish periodic monitoring, trending, and evaluation of performance parameters for the NMP-1 Reactor Building Closed Loop Cooling and NMP-1 Control Room HVAC. • <u>Program Element 6 (Acceptance Criteria)</u> • Provide the controls and sampling necessary to maintain water chemistry parameters in CCCW Systems within the EPRI TR-107396. • Ensure acceptance criteria are specified in the implementing procedures for the applicable indications of degradation. NMP-1 committed to completing these enhancements prior to the period of extended operation. NRC staff reviewed these enhancements and after additional information was provided they were found to be acceptable.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
This program manages the aging effects of reduction of heat transfer due to fouling, or the loss of material from and cracking due to		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
corrosion and/or stress corrosion cracking of the internal surfaces of piping, piping components, and piping elements fabricated from any material and exposed to treated water. Not included are those piping systems that are managed by another AMP. Examples of systems managed by this AMP include closed-cycle cooling water systems (as defined by U.S. Nuclear Regulatory Commission [NRC] Generic Letter [GL] 89-13[2]); closed portions of heating, ventilation, and air conditioning systems; diesel generator cooling water; and auxiliary boiler systems. Examples of systems not addressed by this AMP include boiling water reactor (BWR) coolant, pressurized water reactor (PWR) primary and secondary water, and PWR/BWR condensate systems. Aging in these systems is managed by the water chemistry AMP (XI.M2) and American Society of Mechanical Engineers (ASME) Section XI, Inservice Inspection, Subsections IWB, IWC, and IWD AMP (XI.M1). Treated fire water systems, if present, are also not included in this AMP. The water used in systems covered by this AMP may, but need not, be demineralized. The water used in systems covered by this AMP receives chemical treatment, including corrosion inhibitors. Untreated water systems are addressed using other AMPs, such as Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (XI.M38).		
1.1: No specific concerns for LTO.		
2. Preventive Actions		
This program mitigates aging effects of loss of material and cracking that are due to corrosion and stress corrosion cracking through water treatment. The water treatment program includes corrosion inhibitors and is designed to maintain the function of associated equipment and minimize the corrosivity of the water.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
This program monitors water chemistry (preventive monitoring) and the visual appearance of surfaces exposed to the water (condition monitoring). Depending on the industry standard selected for use in association with this AMP and/or plant operating experience, this program may also include corrosion monitoring (e.g., corrosion coupon testing) and microbiological testing. These parameters (such as the concentration of iron, copper, silica, oxygen; and hardness, alkalinity, specific conductivity, and pH) are monitored because maintenance of optimal water chemistry prevents loss of material and cracking due to corrosion and stress corrosion cracking. In addition, the visual appearance of surfaces provides evidence of the existence of loss of material or cracking. The specific water chemistry parameters monitored and the acceptable range of values for these parameters are in accordance with industry standard guidance documents produced by the Electric Power Research Institute (EPRI), the American Society of Heating Refrigeration and Air-Conditioning Engineers, the Cooling Technology Institute, the American Boiler Manufacturer's Association, ASTM standards, water chemistry guidelines recommended by the equipment manufacturer, Nalco Water Handbook, or the ASME. For closed-cycle cooling water systems as defined in NRC GL 89-13, EPRI 1007820 is used. For other systems, the applicant selects an appropriate industry standard document. In all cases, the selected		

[2] NRC GL 89-13 defines a service water system as "the system or systems that transfer heat from safety-relate structures, systems, or components to the ultimate heat sink." NRC GL 89-13 further defines a closed-cycle system as a part of the service water system that is not subject to significant sources of contamination, one in which water chemistry is controlled and in which heat is not directly rejected to an ultimate heat sink.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
industry standard guidance document is used in its entirety for the water chemistry control or guidance.		
3.1: The various industry water chemistry standards cited here are periodically updated, and the standard in use at the time the plant AMP was prepared will probably not be current at the time of LTO review (see item b.1 above).	Outdated industry standards no longer represent optimal operating procedures and practices. The applicant for subsequent license renewal should be required to update its water chemistry control program as necessary to maintain compliance with current standards.	Verify that the applicant for SLR has maintained current water chemistry standards.
4. Detection of Aging Effects		
In this program, aging effects are detected through water testing and periodic inspections. Water testing ensures that the water treatment program is effective in maintaining acceptable water chemistry. Water testing is conducted in accordance with the selected industry standard. The frequency of water testing is in accordance with the selected industry standard, but in no case should the testing interval be greater than quarterly unless justified with an additional analysis. Because the control of water chemistry may not be fully effective in mitigating the aging effects, visual inspections are conducted. Inspections are conducted whenever the system boundary is opened. Additionally, a representative sample of piping and components is selected based on likelihood of corrosion or cracking and inspected at an interval not to exceed once in 10 years. When required by the ASME Code, inspections are conducted in accordance with the applicable code requirements. In the absence of Code inspection requirements, inspections are conducted in accordance with the selected industry standard. In the event that the selected industry standard does not contain inspection requirements, plant-specific inspection and personnel qualification procedures that are capable of detecting corrosion or cracking may be used. If visual examination identifies adverse conditions, additional examinations, including ultrasonic testing, are conducted. Plant operating experience and/or the industry standard program selected for use in association with this AMP may recommend corrosion testing and/or microbiological testing. If warranted, these tests are conducted in accordance with the industry standard selected or other industry standards appropriate for the conduct of corrosion or microbiological testing.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
Water chemistry data are evaluated against the standards contained in the selected industry standard documents. These data are trended with time, so corrective actions are taken, based on trends in water chemistry, prior to loss of intended function. Inspection results also are trended with time so that the progression of any corrosion or cracking can be evaluated and predicted.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Water chemistry concentrations are maintained within the limits specified in the selected industry standard documents. System components should meet system design requirements, such as minimum wall thickness.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Water chemistry concentrations that are not in accordance with the selected industry standard document should be returned to an "in specification" condition in accordance with the referenced guidelines. Some industry standard documents have time guidelines which govern how rapidly "out of specification" conditions should be corrected. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
As discussed in the Generic Aging Lessons Learned (GALL) Report, the staff finds the requirements 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
Degradation of closed-cycle cooling water systems due to corrosion product buildup (NRC Licensee Event Report [LER] 50-327/93-029-00) or through-wall cracks in supply lines (NRC LER 50-280/91-019-00) has been observed in operating plants. Accordingly, operating experience demonstrates the need for this program.		
10.1: (NMP-1 plant visit) The NMP-1 Program Basis Document for the CCCW system reported numerous incidents of pipe leaks. These included seven incidents of pipe wall thinning from 1996 to 2003 and 10 occurrences of	This is an aging issue that has potentially significant implications for LTO. If one plant is seeing these problems, it is likely that they will turn up at other plants as well. Before granting subsequent license renewal, it will be	Enhance closed treated water system AMP

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
leakage at threaded and mechanical joints from 2001 to 2003. These failures were attributed to a combination of general, galvanic, and flow-assisted corrosion, as well as inadequate design of threaded joints and inadequate wall thickness (schedule 40 rather than the schedule 80 pipe used in replacement). In all cases, the applicant claimed that their CCCW AMP has been effective in detecting and correcting the problems. However, further investigation revealed multiple problems over the years with maintaining nitrogen overpressure in the system surge tank and with multiple system leaks that required significant system makeup over time. These problems appear to have resulted in higher than specified levels of dissolved oxygen in the CCCW chemistry and consequent corrosion problems.	necessary to ensure that these sorts of issues have been addressed, since the CCCW system serves a number of safety-related functions, including emergency diesel generator cooling, the control room HVAC, and heat exchangers in the shutdown cooling system. Where operating experience suggests that a plant has not done a good job of maintaining water chemistry over time, a more rigorous inspection of the closed treated water system SSCs should be required before approving LTO, and the water chemistry program itself should be thoroughly reviewed.	to include a thorough review of plant OE prior to LTO. Where OE indicates water chemistry control problems, require rigorous inspection of system SSCs and review of chemistry control program.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI 1007820, *Closed Cooling Water Chemistry Guideline*, Electric Power Research Institute, Palo Alto, CA, April 2004.

Flynn, Daniel. *The Nalco Water Handbook*, Nalco Company, 2009.

NRC Generic Letter 89-13, *Service Water System Problems Affecting Safety-Related Components*, U.S. Nuclear Regulatory Commission, July 18, 1989.

NRC Generic Letter 89-13, Supplement 1, *Service Water System Problems Affecting Safety-Related Components*, U.S. Nuclear Regulatory Commission, April 4, 1990.

NRC Licensee Event Report 50-280/91-019-00, *Loss of Containment Integrity due to Crack in Component Cooling Water Piping*, October 26, 1991.

NRC Licensee Event Report 50-327/93-029-00, *Inoperable Check Valve in the Component Cooling System as a Result of a Build-Up of Corrosion Products between Valve Components*, December 13, 1993.

A.21 XI.M22 Boraflex Monitoring

The verbatim text of GALL, Rev. 2, AMP XI.M22, Boraflex Monitoring, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
For Boraflex panels in spent fuel storage racks, gamma irradiation and long-term exposure to the wet fuel pool environment causes shrinkage resulting in gap formation, gradual degradation of the polymer matrix, and the release of silica to the spent fuel storage pool water. This results in the loss of boron carbide in the neutron absorber sheets. A monitoring program for the Boraflex panels in the spent fuel storage racks is implemented to assure that no unexpected degradation of the Boraflex material compromises the criticality analysis in support of the design of spent fuel storage racks. This aging management program (AMP) relies on periodic inspection, testing, monitoring, and analysis of the criticality design to assure that the required 5% subcriticality margin is maintained. Therefore, this AMP includes: (a) completing sampling and analysis for silica levels in the spent fuel pool water on a regular basis, such as monthly, quarterly, or annually (depending on Boraflex panel condition), and trending the results by using the EPRI RACKLIFE predictive code or its equivalent; and (b) performing neutron attenuation testing or blackness testing to determine gap formation in Boraflex panels or measuring boron areal density by techniques such as the BADGER device.		
a.1: The program description may need to mention that aging management of spent fuel pools using neutron-absorbing materials other than Boraflex such as Boral, Metamic, boron steel, and Carborundum is addressed in XI.M40 Monitoring of Neutron-Absorbing Material Other Than Boraflex.	It is recommended adding a leading paragraph as below: Many neutron-absorbing materials, such as Boraflex, Boral, Metamic, boron steel, and Carborundum, are used in spent fuel pools. This AMP addresses aging management of spent nuclear pools using Boraflex as neutron-absorbing material. XI.M40, Monitoring of Neutron-Absorbing Material Other Than Boraflex, addresses aging management of spent fuel pools using neutron-absorbing materials other than Boraflex, such as Boral, Metamic, boron steel, and Carborundum.	Update or revise the program description.
Program Basis Documents and/or Supporting Documents		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The supporting documents are NRC IN 95-38 and GL 96-04.		
b.1: No further review item was identified.		
Program Consistency and Commitments		
NMP-1 has the following commitment in the SER Appendix A prior to the PEO: The Boraflex Monitoring Program will be enhanced to (1) require periodic neutron attenuation testing and measurement of boron areal density to confirm the correlation of the conditions of test coupons to those of Boraflex racks that remain in use during the period of extended operation; and (2) establish monitoring and trending instructions for in-situ test results, silica levels, and coupon results (commitment #16).		
c.1: No further review item was identified.		
1. Scope of Program		
This program manages the effect of reduction in neutron-absorbing capacity due to degradation in sheets of neutron-absorbing material made of Boraflex affixed to spent fuel racks.		
1.1: No further review item was identified.		
2. Preventive Actions		
This program is a performance monitoring program and does not include preventive actions.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
The parameters monitored include physical conditions of the Boraflex panels, such as gap formation and decreased boron areal density, and the concentration of the silica in the spent fuel pool. These are conditions directly related to degradation of the Boraflex material. When Boraflex is subjected to gamma radiation and long-term exposure to the spent fuel pool environment, the silicon polymer matrix becomes degraded and silica filler and boron carbide are released into the spent fuel pool water. As indicated in the Nuclear Regulatory Commission (NRC) Information Notice (IN) 95-38 and NRC Generic Letter (GL) 96-04, the loss of boron carbide (washout) from Boraflex is characterized by slow dissolution of silica from the surface of the Boraflex and a gradual thinning of the material. Because Boraflex contains about 25% silica, 25% polydimethyl siloxane polymer, and 50% boron carbide, sampling and analysis of the presence of silica in the spent fuel pool provide an indication of depletion of boron carbide from Boraflex; however, the degree to which Boraflex has degraded is ascertained through measurement of the boron areal density.		
3.1: No further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4. Detection of Aging Effects		
Aging effects on Boraflex panels are detected by monitoring silica levels in the spent fuel storage pool on a regular basis, such as monthly, quarterly, or annually (depending on Boraflex panel condition); by performing blackness testing to measure gap formation or measuring boron areal density on a frequency determined by the material condition of the Boraflex panels, with a minimum frequency of once every 5 years; and by applying predictive methods to the measured results. The amount of boron carbide present in the Boraflex panels is determined through direct measurement of boron areal density by blackness testing or by periodic verification of boron loss through areal density measurement techniques, such as the BADGER device. Frequent Boraflex testing is sufficient to ensure that Boraflex panel degradation does not compromise criticality analysis for the spent fuel pool storage racks. Additionally, changes in the level of silica present in the spent fuel pool water provide an indication of changes in the rate of degradation of Boraflex panels.		
4.1: (NMP-1 plant audit) SER (NUREG 1900) Section 3.0.3.2.9 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels in NMP-1. The NMP-1 spent fuel pool has both Boraflex and Boral panels. The AMP may need some guidelines on the applicability of this AMP in a spent fuel pool that contains both Boraflex and materials other than Boraflex.	Adding guidelines on the applicability of this AMP in a spent fuel pool that contains both Boraflex and neutron-absorbing materials other than Boraflex is recommended.	Revise or update AMP program element.
5. Monitoring and Trending		
The periodic inspection measurements and analysis are compared to values of previous measurements and analysis providing a continuing level of data for trend analysis. Sampling and analysis for silica levels in the spent fuel pool water is performed on a regular basis, such as monthly, quarterly, or annually (depending on Boraflex panel condition), and results are trended using the EPRI RACKLIFE predictive code or its equivalent. The frequency to perform blackness testing will be determined by the material condition of the Boraflex panels, with a maximum of 5 years.		
5.1: (NMP-1 audit) The GALL report states: Sampling and analysis for silica levels in the spent fuel pool water is performed on a regular basis, such as monthly, quarterly, or annually (depending on Boraflex panel condition), and results are trended using the EPRI RACKLIFE predictive code or its equivalent. The NMP-1 Audit report states: Silica concentration in the spent fuel pool water serves as an	Add a statement in the NMP-1 Audit Report stating that: (a) Sampling and analysis for silica levels in the spent fuel pool water is performed on a regular basis, such as monthly, quarterly, or annually (depending on Boraflex panel condition), and results are trended using the EPRI RACKLIFE predictive code or its equivalent. (b) Silica concentration in the spent fuel pool water serves as an indicator of the amount of Boraflex dissolution occurring in the	Revise or update AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
indicator to the amount of Boraflex dissolution occurring in the spent fuel racks. It is important to trend the silica concentration against time and monitor for rapid silica excursions indicating accelerated Boraflex degradation.	spent fuel racks. It is important to trend the silica concentration against time and monitor for rapid silica excursions indicating accelerated Boraflex degradation.	
6. Acceptance Criteria		
The 5% subcriticality margin of the spent fuel racks is maintained for the period of extended operation.		
6.1: (NMP-1 plant audit) SER (NUREG 1900) Section 3.0.3.2.9 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels in NMP-1. The NMP-1 spent fuel pool has both Boraflex and Boral panels. The AMP may need some guidelines and clarification on the acceptance criteria of 5% subcriticality margin of the spent fuel racks for a spent fuel pool containing both Boraflex and non-Boraflex (Boral) neutron-absorbing materials.	Providing guidance on the acceptance criteria for spent fuel racks for a spent pool containing both Boraflex and non-Boraflex (Boral) neutron-absorbing materials is recommended.	Update or revise the AMP program element.
7. Corrective Actions		
Corrective actions are initiated if the test results find that the 5% subcriticality margin cannot be maintained because of the current or projected future degradation. Corrective actions consist of providing additional neutron-absorbing capacity by Boral® or boron steel inserts or other options which are available to maintain a subcriticality margin of 5%. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, site review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
NRC IN 87-43 addresses the problems of development of tears and gaps (average 1-2 inches, with the largest 4 inches) in Boraflex sheets due to gamma radiation-induced shrinkage of the material. NRC IN 93-70, NRC IN 95-38, and NRC GL 96-04 address several cases of significant degradation of Boraflex test coupons due to accelerated dissolution of Boraflex caused by pool water flow through panel enclosures and high accumulated gamma dose. Two spent fuel rack cells with about 12 years of service have only 40% of the Boraflex remaining. In such cases, the Boraflex may be replaced by boron steel inserts or by a completely new rack system using Boral®. Experience with boron steel is limited; however, the application of Boral® for use in the spent fuel storage racks predates the manufacturing and use of Boraflex. The experience with Boraflex panels indicates that coupon surveillance programs are not reliable. Therefore, during the period of extended operation, the measurement of boron areal density correlated, through a predictive code, with silica levels in the pool water, is verified. These monitoring programs provide assurance that degradation of Boraflex sheets is monitored so that appropriate actions can be taken in a timely manner if significant loss of neutron-absorbing capability is occurring. These monitoring programs provide reasonable assurance that the Boraflex sheets maintain their integrity and are effective in performing their intended function.		
10.1: No further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

BNL-NUREG-25582, *Corrosion Considerations in the Use of Boral in Spent Fuel Storage Pool Racks*, January 1979.

EPRI NP-6159, *An Assessment of Boraflex Performance in Spent-Nuclear-Fuel Storage Racks*, Electric Power Research Institute, Palo Alto, CA, December 14, 1988.

EPRI 1003413, *Guidance and Recommended Procedure for Maintaining and Using RACKLIFE Version 1.10*, Electric Power Research Institute, Palo Alto, CA, April 2002.

EPRI TR-101986, *Boraflex Test Results and Evaluation*, Electric Power Research Institute, Palo Alto, CA, March 1, 1993.

EPRI TR-103300, *Guidelines for Boraflex Use in Spent-Fuel Storage Racks*, Electric Power Research Institute, Palo Alto, CA, December 1, 1993.

NRC Generic Letter 96-04, *Boraflex Degradation in Spent Fuel Pool Storage Racks*, U.S. Nuclear Regulatory Commission, June 26, 1996.

NRC Information Notice 87-43, *Gaps in Neutron Absorbing Material in High Density Spent Fuel Storage Racks,* U.S. Nuclear Regulatory Commission, September 8, 1987.

NRC Information Notice 93-70, *Degradation of Boraflex Neutron Absorber Coupons*, U.S. Nuclear Regulatory Commission, September 10, 1993.

NRC Information Notice 95-38, *Degradation of Boraflex Neutron Absorber in Spent Fuel Storage Racks*, U.S. Nuclear Regulatory Commission, September 8, 1995.

NRC Regulatory Guide 1.26, Rev. 3, *Quality Group Classifications and Standards for Water, Steam, and Radioactive-Waste-Containing Components of Nuclear Power Plants (for Comment),* U.S. Nuclear Regulatory Commission, February 1976.

A.22 XI.M23 Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems

The verbatim text of GALL, Rev. 2, AMP XI.M23, Inspection of Overhead Heavy Load and Light Loads (Related to Refueling) Handling Systems, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Most commercial nuclear facilities have between 50 and 100 cranes. Many are industrial grade cranes, which meet the requirements of 29 CFR Volume XVII, Part 1910, and Section 1910.179. Most are not within the scope of 10 CFR 54.4 and therefore are not required to be part of the integrated plant assessment. Because only a few cranes operate over safety-related equipment, normally fewer than 10 cranes fall within the scope of 10 CFR 54.4. Many of the systems and components of these cranes perform an intended function with moving parts or with a change in configuration or are subject to replacement based on qualified life. In these instances, these types of crane systems and components are not within the scope of this aging management program. This program is primarily concerned with structural components that make up the bridge and trolley. NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants," provides specific guidance on the control of overhead heavy load cranes. The aging management activities specified in this program utilize the guidance provided in American Society of Mechanical Engineers (ASME) Safety Standard B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)."		
a.1: (Ginna and NMP-1 plant visit) NRC IN 2009-20 reports several cases of cable failures due to fatigue. The program description needs to mention cable failures due to fatigue.	Expanding the program description in addressing cable failures due to fatigue is recommended.	Revise program description
Program Basis Documents and/or Supporting Documents		
NRC IN 2009-20, "Degradation of Wire Rope Used in Fuel Handling Applications		
b.1: NRC IN 2009-20, "Degradation of Wire Rope Used in Fuel Handling Applications," reported that fatigue caused the crane wire strands to fail in the LaSalle refueling machine; fleet-wide inspection was initiated. In 2007, wire rope failure caused by fatigue occurred in the Beaver Valley fuel building. The license found that the wire rope was in	Revise or update AMP program elements based on NRC IN 2009-20 as appropriate and add the IN to the references.	Revise AMP program elements as appropriate.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
service for 24 years. Because of interferences with other components, the wire rope may have not have received a complete underwater inspection. Corrective actions included establishing new repetitive preventive-maintenance tasks to perform fuel transfer equipment cable and shaves inspections. IN 2009-20 also reports that degradation of the main hoist cables occurred in the Browns Ferry plant in 2007. The licensee enhanced inspection programs to monitor conditions of the wire rope.		
Program Consistency and Commitments		
NMP-1 has the following commitment in the SER Appendix A prior to the PEO: Revise applicable procedures related to the Crane Inspection Program to add specific direction for the performance of corrosion inspections, with acceptance criteria, for certain hoist lifting assembly components.		
c.1: No further review item was identified.		
1. Scope of Program		
The program manages (a) the effects of loss of material due to general corrosion on the bridge rails, bridge, and trolley structural components for those cranes that are within the scope of 10 CFR 54.4, and (b) the effects of wear on the rails in the rail system. The program also manages the effects of loss of preload of bolted connections.		
1.1 Several cases of cable failures due to fatigue are reported in NRC IN 2009-20.	Expand the scope of program to include aging management of cables and wires due to fatigue in the Scope and revise the AMP table.	Update AMP program element.
2. Preventive Actions		
This program is a condition monitoring program. No preventive actions are identified.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
Surface condition is monitored by visual inspection to ensure that loss of material is not occurring due to corrosion or wear. Bolted connections are monitored for loose bolts, missing or loose nuts, and other conditions indicative of loss of preload.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
3.1: High-strength bolts could experience SCC.	Adding SCC is recommended for monitoring, in addition to loose bolts, missing or loose nuts, and other conditions indicative of loss of preload.	Revise AMP program element.
4. Detection of Aging Effects		
Crane rails and structural components are visually inspected at a frequency in accordance ASME B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)," or other appropriate standard in the ASME B30 series. For systems that are infrequently in service, such as containment polar cranes, periodic inspections are performed once every refueling cycle just prior to use. Bolted connections are visually inspected for loose bolts or missing nuts at the same frequency as crane rails and structural components.		
4.1: High-strength bolts could experience SCC.	Adding SCC is recommended for monitoring and inspection in addition to loose bolts, and missing or loose nuts.	Revise AMP program element.
4.2: Several cases of cable failures due to fatigue are reported in NRC IN 2009-20.	Expand the program element to include aging management of cables and wires due to fatigue and provide guidance on inspection methods and acceptance criteria for the wire ropes.	Update AMP program element.
5. Monitoring and Trending		
Visual inspection activities are performed by personnel qualified in accordance with controlled procedures and processes. Deficiencies are documented using applicant-approved processes and procedures, such that results can be trended; however, the program does not include formal trending.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Any visual indication of loss of material due to corrosion or wear and any visual sign of loss of bolting pre-load is evaluated according to ASME B30.2 or other applicable industry standard in the ASME B30 series.		
6.2: Several cases of cable failures due to fatigue are reported in NRC IN 2009-20.	Expand the program element to include aging management of cables and wires due to fatigue and provide guidance on inspection methods and acceptance criteria for the wire ropes.	Update AMP program element.
7. Corrective Actions		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Repairs are performed as specified in ASME B30.2 or other appropriate standard in the ASME B30 series. Site corrective actions program, quality assurance (QA) procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.		
7.1: No further review item was identified.		
8. Confirmation Process		
Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
There has been no history of corrosion-related degradation that threatened the ability of a crane to perform its intended function. Likewise, because cranes have not been operated beyond their design lifetime, there have been no significant fatigue-related structural failures. Operating experience indicates that loss of bolt preload has occurred, but not to the extent that it has threatened the ability of a crane structure to perform its intended function.		
10.1: Several cases of cable failures due to fatigue are reported in NRC IN 2009-20.	Expand the program element to include the cases of cable failures in NRC IN 2009-20.	Update AMP OE.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 54.4, *Scope*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Safety Standard B30.2, *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist),* American Society of Mechanical Engineers, 2005.

NRC Generic Letter 80-113, *Control of Heavy Loads*, U.S. Nuclear Regulatory Commission, December 22, 1980.

NRC Generic Letter 81-07, *Control of Heavy Loads*, U.S. Nuclear Regulatory Commission, February 3, 1981.

NRC Regulatory Guide 1.160, Rev. 2, *Monitoring the Effectiveness of Maintenance at Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, March 1997.

NUREG-0612, *Control of Heavy Loads at Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, 1980.

A.23 XI.M24 Compressed Air Monitoring

The verbatim text of GALL, Rev. 2, AMP XI.M24, Compressed Air Monitoring, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of the compressed air monitoring program is to provide reasonable assurance of the integrity of the compressed air system. The program consists of monitoring moisture content, corrosion, and performance of the compressed air system. This includes (a) preventive monitoring of water (moisture) and other potential contaminants to keep within the specified limits; and (b) inspection of components for indications of loss of material due to corrosion. The compressed air monitoring aging management program (AMP) is based on results of the plant owner's response to Nuclear Regulatory Commission (NRC) Generic Letter (GL) 88-14 (as applicable to license renewal) and reported in previous NRC Information Notices (IN) 81-38; IN 87-28; IN 87-28, Supplement 1; and by the Institute of Nuclear Power Operations Significant Operating Experience Report (INPO SOER) 88-01. NRC GL 88-14, issued after several years of study of problems and failures of instrument air systems, recommends that each holder of an operating license perform an extensive design and operations review and verification of its instrument air system. NRC GL 88-14 also recommends that the licensees describe their program for maintaining proper instrument air quality. This AMP does not include all aspects of NRC GL 88-14 because many of the issues in the GL are not relevant to license renewal. This AMP does not change the applicant's docketed response to NRC GL 88-14 for the rest of its operations. The program utilizes the aging management aspects of the applicant's response to NRC GL 88-14 for license renewal with regard to preventative measures, inspections of components, and testing to ensure that the compressed air system will be able to perform its intended function for the period of extended operation. The AMP also incorporates the air quality provisions provided in the guidance of the Electric Power Research Institute (EPRI) NP-7079. EPRI NP-7079 was issued in 1990 to assist utilities in identifying and correcting system problems in the instrument air system and to enable them to maintain required industry safety standards. The American Society of Mechanical Engineers (ASME) operations and maintenance standards and guides (ASME OM-S/G-1998, Part 17) provides additional guidance for maintenance of the instrument air system by offering recommended test methods, test intervals, parameters to be measured and evaluated, acceptance criteria, corrective actions, and records requirements.		
a.1: No specific concerns for LTO.		
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description, the guidance in 10 CFR 50, Appendix B; NRC Generic Letter 88-14;		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
INPO SOER 88-01; ASME OM-S/G-1998, Part 17; ANSI/ISA-S7.0.01-1996; EPRI NP-7079; and EPRI TR-108147. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0. The Ginna Compressed Air Monitoring Program (B2.1.10) cites only 10 CFR 50, Appendix B, and NRC Generic Letter 88-14. However, Ginna did not credit this AMP for managing or monitoring aging effects for SSCs within the scope of license renewal and subject to an AMR. Therefore, the NRC staff did not evaluate this program for license renewal. The NMP-1 Compressed Air Monitoring Program (B2.1.14) cites 10 CFR 50, Appendix B; NRC GL 88-14; INPO SOER 88-01; ASME OM-S/G-1998, Part 17; ANSI/ISA-S7.3-1975; and EPRI TR-108147.		
b.1: (Ginna & NMP-1 plant visits) The LRAs for both plants that were audited cite only a part of the program basis and supporting documents identified in GALL, Rev. 2. In addition, some of the guidance documents cited in GALL and in the LRAs are subject to periodic updating.	Unless the program basis and supporting documents are current and complete, the applicant's AMP for LTO will not represent the best available guidance for aging management.	Verify that the guidance cited in the AMP for LTO is current and complete.
Program Consistency and Commitments		
Ginna did not credit its Compressed Air Monitoring Program (B2.1.10) for managing or monitoring aging effects for SSCs within the scope of license renewal and subject to an AMR, and the NRC staff did not evaluate this program for license renewal. The NMP-1 amended LRA Compressed Air Monitoring Program (B2.1.14) states that it includes good practice elements of the general maintenance and inspection activities for the compressor, receiver, and air dryer discussed in EPRI TR-108147 (revision to EPRI NP-7079) and ASME OM-S/G-1998, Part 17. However, specific exception is made for any maintenance recommended in EPRI TR-1 08147 that is not also endorsed by the equipment manufacturers, and to the pre-service and inservice testing guidelines in ASME OM-S/G-1 998, Part 17. The justification for these exceptions is that there have been no age-related failures in this system under the current program. After clarification concerning air quality standards, the NRC found these exceptions to be acceptable. Enhancements to the NMP-1 Compressed Air Monitoring Program encompass revisions to existing activities that are credited for license renewal to ensure the applicable aging effects are discovered and evaluated. The program elements affected are as follows: <u>Elements 1, 2, and 4 (Scope of Program, Preventive Action, and Detection of Aging Effects)</u> • Develop new activities to manage the loss of material and SCC, and perform periodic system leak checks. • Expand scope, periodicity, and inspection techniques to ensure that the aging of certain sub-components of the dryers and compressors (e.g., valves, heat exchangers) are managed. • Develop and implement activities to address the failure mechanism of SCC in unannealed red brass piping. <u>Element 5 (Monitoring and Trending)</u> • Establish activities that manage the aging of the internal surfaces of carbon steel piping and that require system leak checks to detect deterioration of the pressure boundaries.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Element 6 (Acceptance Criteria) • Expand the acceptance criteria to ensure that the aging of certain subcomponents of the dryers and compressors (e.g., valves, heat exchangers) are managed. The NRC found these enhancements to be acceptable. NMP committed to implementing these enhancements prior to entering the period of extended operation, and the NRC found the enhanced Open Cycle Cooling Water System Program to be acceptable.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
The program manages the aging effects of loss of material due to corrosion in compressed air systems.		
1.1: (Ginna plant visit) The Ginna LRA contains only a summary description of its Compressed Air Monitoring Program, and the applicant did not credit this program for monitoring or managing aging effects of components within the scope of license renewal. Instead, the LRA cites the applicant's June 17, 1991, response to GL 88-14, which stated that air-operated valves at Ginna were verified to fail-safe on loss of air, and that therefore the compressed air systems at Ginna did not perform a safety function. During the LTO audit, the licensee stated that aging effects on components within the system were managed through the site's system engineering program. A self-assessment of the instrument air system was performed in 2010, which evaluated the adequacy of the current program with recommendations 4 and 5 given in the applicant's document SOER 88-1, "Instrument Air System Failures." The licensee identified eight improvements during their assessment to strengthen the program. In addition, condition reports including receiver tank wall thickness measurements indicated that the program was effectively identifying issues.	The absence of a stand-alone AMP to manage component aging in the compressed air system raises concerns for LTO. As stated in the above program description, even though the compressed air system may be identified as not directly performing a safety-related function, the compressed air provides the motive power for instruments and active components (some of them safety-related) that may not function properly if non-safety Group D equipment is contaminated.	Consider requiring the development of a separate stand-alone AMP to manage aging in the compressed air system for LTO.
2. Preventive Actions		
For the purposes of aging management, moisture and other corrosive contaminants in the system's air are maintained below specified		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
limits to ensure that the system and components maintain their intended functions. These limits are prepared from consideration of manufacturer's recommendations for individual components and guidelines based on ASME OM-S/G-1998, Part 17; American National Standards Institute (ANSI)/ISAS7.0.01-1996; EPRI NP-7079; and EPRI TR-108147.		
2.1: (NMP-1 plant visit) The NMP-1 Compressed Air Monitoring Program made an exception for GALL, Rev. 2, guidance in program element 2 that preventive actions take into account manufacturer's recommendations for individual components and guidelines based on ASME OM-S/G-1998, Part 17; American National Standards Institute (ANSI)/ISAS7.0.01-1996; EPRI NP-7079; and EPRI TR-108147. Specifically, the applicant made an exception for any maintenance recommended in EPRI TR-108147 that is not also endorsed by the equipment manufacturers and for the pre-service and inservice testing guidelines in ASME OM-S/G 1998, Part 17. The justification for these exceptions is that there have been no age-related failures in this system under the current program.	In general, the compressed air system at NMP-1 has been relatively trouble-free. The exception is that internal and external cracking of red brass components in the system has been observed in the past, and all of the red brass components in the system have since been replaced. It was subsequently determined that red brass should not have been used in the first place, but it was apparently introduced through fabricator or vendor error.	Any uptick in component problems during the initial 20-year life extension will require a reevaluation of this exception to GALL Program Element 2 guidance.
3. Parameters Monitored/Inspected		
Maintaining moisture and other corrosive contaminants below acceptable limits mitigates loss of material due to corrosion. Periodic air samples are taken and analyzed for moisture and other corrosives. Periodic and opportunistic inspections of accessible internal surfaces are performed for signs of corrosion and abnormal corrosion products that might indicate a loss of material within the system.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
Moisture and other corrosives increase the potential for loss of material due to corrosion. The program periodically samples and tests the air quality in the compressed system for moisture in accordance with industry standards, such as ANSI/ISAS7.0.01-1996. Typically, compressed systems have in-line dew point instrumentation that either checks continuously using an automatic alarm system or is checked at least daily to ensure that moisture content is within specifications. Additionally, periodic visual inspections of critical component internal surfaces (compressors, dryers, after-coolers, and filters) are performed for signs of loss of material due to corrosion. ASME O/M-S/G-1998, Part 17 provides guidance for inspection frequency and inspection methods of these components.		
4.1: No specific concerns for LTO.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
5. Monitoring and Trending		
Daily readings of system dew point are recorded and trended. Air quality analysis results are reviewed to determine if alert levels or limits have been reached or exceeded. This review also checks for unusual trends. ASME O/M-S/G-1998, Part 17, provides guidance for monitoring and trending data. Visual inspection results are compared to previous results to ascertain if adverse long-term trends exist. The effects of corrosion are monitored by visual inspection. Test data are analyzed and compared to data from previous tests to provide for the timely detection of aging effects on passive components.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
Acceptance criteria for air quality moisture limits are established based on accepted industry standards, such as ANSI/ISA-S7.0.01-1996. Internal surfaces should not show signs of corrosion (general, pitting, and crevice) that could indicate the potential loss of function of the component. Manufacturers' certifications can be used to demonstrate that the bottled air meets acceptable quality standards.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Corrective actions are taken if any parameters are out of acceptable ranges, such as moisture content in the system air. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
The site corrective actions program, quality assurance (QA) procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Potentially significant safety-related problems pertaining to air systems have been documented in NRC IN 81-38; IN 87-28; IN 87-28, Supplement 1; and License Event Report 50-237/94-005-3. Some of the systems that have been significantly degraded or that have failed due to the problems in the air system include the decay heat removal, auxiliary feedwater, main steam isolation, containment isolation, and fuel pool seal systems. In 2008, one plant incurred an unplanned reactor trip from a failure of a mechanical joint in the instrument air system (NRC IN 2008-06). Nevertheless, as a result of NRC GL 88-14 and in consideration of INPO SOER 88-01, EPRI NP-7079, and EPRI TR-108147, performance of air systems has improved significantly.		
10.1: Aside from the notable exceptions cited above, operating experience with the compressed air systems a nuclear plant has been generally favorable. However, it is essential to continue to closely monitor future industry operating experience, particularly during the initial 20-year license extension period.	Any increase in component degradation in the compressed air systems will require a reevaluation and possible revision of the current AMP XI.M24 before it is applied to LTO.	Revise AMP as necessary for LTO in response to future OE.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ANSI/ISA-S7.0.01-1996, *Quality Standard for Instrument Air*, American National Standards Institute (ANSI), 1996.

ASME OM-S/G-1998, Part 17, *Performance Testing of Instrument Air Systems Information Notice Light-Water Reactor Power Plants*, 1ISA-S7.0.1-1996, "Quality Standard for Instrument Air," American Society of Mechanical Engineers, New York, NY, 1998.

EPRI NP-7079, *Instrument Air System: A Guide for Power Plant Maintenance Personnel*, Electric Power Research Institute, Palo Alto, CA, December 1990.

EPRI/NMAC TR-108147, *Compressor and Instrument Air System Maintenance Guide*: Revision to NP-7079, Electric Power Research Institute, Nuclear Maintenance Application Center, Palo Alto, CA, March 1998.

INPO Significant Operating Experience Report 88-01, *Instrument Air System Failures*, Institute of Nuclear Power Operations, May 18, 1988.

NRC Generic Letter 88-14, *Instrument Air Supply Problems Affecting Safety-Related Components*, U.S. Nuclear Regulatory Commission, August 8, 1988.

NRC Information Notice 81-38, *Potentially Significant Components Failures Resulting from Contamination of Air-Operated Systems*, U.S. Nuclear Regulatory Commission, December 17, 1981.

NRC Information Notice 87-28, *Air Systems Problems at U.S. Light Water Reactors*, U.S. Nuclear Regulatory Commission, June 22, 1987.

NRC Information Notice 87-28, Supplement 1, *Air Systems Problems at U.S. Light Water Reactors*, U.S. Nuclear Regulatory Commission, December 28, 1987.

NRC Information Notice 2008-06, *Instrument Air System Failure Resulting In Manual Reactor Trip*, U.S. Nuclear Regulatory Commission, April 10, 2008.

NRC Licensee Event Report 50-237/94-005-3, *Manual Reactor Scram due to Loss of Instrument Air Resulting from Air Receiver Pipe Failure Caused by Improper Installation of Threaded Pipe during Initial Construction*, U.S. Nuclear Regulatory Commission, April 23, 1997.

A.24 XI.M25 BWR Reactor Water Cleanup System

The verbatim text of GALL, Rev. 2, AMP XI.M25, BWR Reactor Water Cleanup System, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visit to NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program addresses inspection to manage the aging effects of cracking due to stress corrosion cracking (SCC) or intergranular stress corrosion cracking (IGSCC) on the intended function of austenitic stainless steel (SS) piping outboard of the second primary containment isolation valves in the reactor water cleanup (RWCU) system. Based on the Nuclear Regulatory Commission (NRC) criteria related to inspection guidelines for RWCU piping welds outboard of the second isolation valve, the program includes the measures delineated in NUREG-0313, Rev. 2, and in NRC Generic Letter (GL) 88-01 and its Supplement 1. The aging management review (AMR) Item in the GALL Report that credits this program also credits AMP XI.M2, "Water Chemistry," to provide mitigation of the aging effects. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry program. The NRC GL 88-01 applies to all boiling water reactor (BWR) piping made of austenitic SS that is 4 inches or larger in nominal diameter and contains reactor coolant at a temperature above 93.3°C (200°F) during power operation regardless of code classification. The NRC GL 88-01 requests, in part, that affected licensees implement an ISI program conforming to staff positions for austenitic SS piping covered under the scope of the letter. In response to NRC GL 88-01, affected licensees undertook ISI in accordance with the scope and schedules described in the letter and included affected portions of RWCU piping outboard of the second isolation valves in their ISI programs. The NRC issued GL 88-01, Supplement 1, to provide acceptable alternatives to staff positions delineated in NRC GL 88-01. In NRC GL 88-01, Supplement 1, the staff noted, in part, that the position stated in NRC GL 88-01 on inspection sample size of RWCU system welds outboard of the second isolation valves had created an unnecessary hardship for affected licensees because of the very high radiation levels associated with this portion of RWCU piping. The staff also noted that affected licensees had requested that they be exempted from NRC GL 88-01 with regard to inspection of this piping of the RWCU system. Although NRC GL 88-01, Supplement 1, does not provide explicit generic guidance with regard to staff criteria for reduction or elimination of RWCU weld inspections, it does suggest that the staff would be receptive to modifications to a licensee's original docketed NRC GL 88-01 response for RWCU weld inspections, provided all issues of reactor safety were adequately addressed. The staff has subsequently allowed individual licensees to modify their docketed responses to GL-88-01 to reduce or eliminate their ISI of RWCU welds in the piping outboard of the second isolation valves. This AMP is based on the staff-approved screening criteria for the inspection.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		
The following documents provide either the basis for this AMP or additional guidance for the AMP: (a) This AMP is based on the staff-approved screening criteria for inspection of RWCU system piping welds outboard of the second isolation valve (enclosure in letter from Shea, NRC, to Hunger, Jr., PECO Energy Company). (b) The screening criteria consider satisfactory completion of all actions requested in GL 89-10. (c) Based on the screening criteria, the inspection guidelines for RWCU system piping welds outboard of the second isolation valve include the measures delineated in NUREG-0313, Rev. 2, and NRC GL 88-01 and its Supplement 1. (d) The program also includes water chemistry control in accordance with the water chemistry program XI.M2.		
b.1: Although the program description of the GALL AMP refers to these documents, the significance of the documents is not obvious. For example, although the GALL, Rev. 2, AMP mentions the NRC screening criteria in the second sentence of the first paragraph of the program description, and again in the last sentence of the third paragraph, the detailed description of the criteria is buried in the middle of the description of program element 4 for detection of aging effects.	Since the inspection guidelines recommended in this AMP are essentially based on the screening criteria, it would be very useful to clearly describe the NRC screening criteria either in the program description after the first paragraph, or in the scope of the program section, as was the case in GALL, Rev. 1.	Clearly identify the significance of basis and supporting documents.
Program Consistency and Commitments		
The NMP-1 LRA states that its AMP for BWR RWCU system <u>is consistent</u> with the <u>GALL, Rev. 0,</u> AMP XI.M25, with one exception: the GALL AMP cites ASME Section XI requirements covered in 1995 edition through 1996 addenda, whereas the NMP-1 inspections are based on 1989 edition of the Code.		
c.1: (NMP-1 plant visit) This exception regarding an earlier edition of the Code was found acceptable by the NRC staff.	Such exceptions are relatively common in LRAs. It may be useful to revise the AMP to recognize that inspection requirements of earlier editions of the ASME Code Section XI are acceptable for the RWCU system.	Revise program description to include acceptance of earlier editions.
1. Scope of Program		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
This program provides an ISI protocol to manage the aging effects of cracking due to SCC or IGSCC in austenitic SS piping outboard of the second containment isolation valves in the RWCU system. The components included in this program are the welds in piping that have a nominal diameter of 4 inches or larger and that which contain reactor coolant at a temperature above 93°C (200°F) during power operation, regardless of code classification.		
1.1: (NMP-1 plant visit) The program basis document for the BWR RWCU System AMP indicates: 1. Satisfactory completion of all actions requested in GL 89-10; 2. No indication of IGSCC in RWCU system welds inboard of isolation valves; 3. No IGSCC of RWCU system outboard welds after an inspection of 10% of outboard welds; and, 4. After meeting the three criteria for eliminating any further inspection, two RWCU system piping welds outboard of the second isolation valve were identified with pressure boundary leakage. Both welds were repaired by a full structural weld overlay, and reclassified to IGSCC Category E in accordance with GL 88-01.	The identification of leakage from the two outboard welds has caused a deviation from the previous compliance of the third criteria (no IGSCC in the outboard welds) and, therefore, in accordance with the recommendations of the GALL AMP, an inspection of at least 2% of the welds or two welds, whichever is greater, needs to be performed on the portions of the RWCU system outboard of the second isolation valves every refueling outage. The licensee, however, is inspecting only one weld out of 30 welds during each refueling outage, which is not consistent with the GALL AMP XI.M25. To ensure consistency with the GALL AMP, the screening criteria should be clearly described in the program description.	Include screening criteria in scope of program.
2. Preventive Actions		
The comprehensive program outlined in NUREG-0313 and NRC GL 88-01 addresses improvements in all three elements that, in combination, cause and potentially accelerate SCC or IGSCC. These elements are a susceptible (sensitized) material, a significant tensile stress, and an aggressive environment. The program delineated in NUREG-0313 and NRC GL 88-01 includes recommendations regarding selection of materials that are resistant to sensitization, use of special processes that reduce residual tensile stresses, and monitoring and maintenance of controlled coolant chemistry. The resistant materials are used for new and replacement components and include low-carbon grades of austenitic SS and weld metal, with a maximum carbon of 0.035 wt.% and a minimum ferrite of 7.5% in weld metal and cast austenitic stainless steel (CASS). Special processes are used for existing as well as new and replacement components. These processes include solution heat treatment, heat sink welding, induction heating, and mechanical stress improvement.		
2.1: (NMP-1 plant visit) The NMP-1 is currently operating under HWC/NMCA to mitigate IGSCC. An adverse effect of implementing HWC is an increase in the drywell shutdown dose rate. The main reason for this is a conversion of the oxide film from Fe_2O_3 type to a spinel	The measured ECP at NMP-1 has continually been observed at -400mV or less and an injection rate of 4 scfm represents ~0.16 ppm hydrogen in FW. However, a 400% increase in shutdown dose rate was	Obtain information on OE for HWC/NMCA and include

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
F_3O_4 type oxide. This conversion resulted in the release of some soluble radioisotopes such as Co-60, which deposit on surfaces of the reactor coolant pressure boundary components. At NMP-1, the HWC/NMCA effectiveness is monitored by ECP measurement probes installed on a reactor recirculation system flange and in the mitigation monitoring system (MMS) supplied from the RWCU system inlet line, and from catalytic loading (noble metal) measurements from MMS coupons. The noble metal chemical addition (NMCA) system includes permanent monitoring equipment, as well as connections for periodically injecting a noble metal solution. It draws a sample from the RWCU system, analyzes the effectiveness of the noble metal treatment in the durability monitor, and returns the sample to the RWCU system. Secondary parameters being measured include feed water (FW) hydrogen flow rate or concentration, reactor water oxygen, measured H_2:O_2 molar ratio, and H_2:O_2 molar ratio from Rad/ECP model.	observed at NMP-1 after 27 months of post-NMCA operation. The reason being that NMP-1, until recently, has been a low Zn input plant. Typically, when enough hydrogen is injected to make the noble metal surface catalytic, the electrochemical potential (ECP) of BWR surfaces will be at -490 mV standard hydrogen electrode and a pure spinel film will be present. In such a situation, if enough Zn is present in the water, it would overwhelm the Co-60 in the race to be incorporated into the spinal lattice. However, if enough Zn is not present, the much larger Co-60 atoms will fill the available lattice sites. The post shutdown dose rate is primarily determined by water-soluble Co-60 to soluble zinc ratio in the reactor. A ratio of 2×10^{-05} μCi/ml/ppb is recommended, which is achieved by a FW Zn injection up to 0.8 ppb. Since NMP-1 is the first plant to implement NMCA, information regarding plant OE during the initial period after NMCA was implemented would be very useful to test and confirm expected behavior. In particular, it would be useful to know the effects of a higher concentration of iron or Co-60 in reactor water, or deposits of Co-60 on surfaces, or of Zn on fuel rods.	relevant guidance, if any after development.
3. Parameters Monitored/Inspected		
The aging management program (AMP) monitors SCC or IGSCC of austenitic SS piping by detecting and sizing cracks in accordance with the requirements of American Society of Mechanical Engineers (ASME) Code, Section XI; the guidelines in NUREG-0313, NRC GL 88-01, and NRC GL 88-01, Supplement 1; and the NRC screening criteria as described in Element 4 for the RWCU piping outboard of the second isolation valves.		
3.1: No significant concern or further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4. Detection of Aging Effects		
The extent, method, and schedule of the inspection and test techniques delineated in the NRC inspection criteria for RWCU piping and NRC GL 88-01 are designed to maintain structural integrity and to detect aging effects early and well before the loss of intended function of austenitic SS piping and fittings. Guidelines for the inspection schedule, methods, personnel, sample expansion, and leak detection guidelines are based on the guidelines of guidelines in NRC GL 88-01 and GL 88-01, Supplement 1, and subsequent licensing correspondence. Consistent with the NRC guidelines and with licensees' completion of all actions requested in NRC GL 89-10, no inspection of the outboard piping is required for (a) piping systems that are made of IGSCC-resistant piping materials or (b) piping with no IGSCC detected inboard of the second isolation valves (ongoing GL 88-01 inspection) and outboard of the second isolation valves (after inspecting a minimum of 10% of susceptible piping welds). For piping that includes a non-resistant base or weld material in the scope of the program or piping that has experienced IGSCC, either inboard or outboard of the second isolation valves, an inspection of at least 2% of the welds or two welds, whichever is greater, is performed on the portions of the RWCU system outboard of the second isolation valves during every refueling outage.		
4.1: (NMP-1 plant visit) The extent and frequency of inspections recommended by the program are based on the condition of each weld (e.g., whether the welds were made from IGSCC-resistant material and whether a stress improvement process was applied to a weld to reduce the residual stresses, and how the weld was repaired if it had been cracked).	The fourth-interval inservice inspection plan indicates that Category D welds are those welds not made with resistant materials, and have not been given an stress improvement treatment, but have been examined and found to be free of cracks. The inspection plan also indicates that Category D includes all bimetallic nozzle welds made with non-resistant material and 182 Inconel weld butter. In other words, the licensee's aging management identifies Alloy 182 welds as non-resistant material.	Relevant information, no action required.
5. Monitoring and Trending		
The extent and schedule for inspection in accordance with the recommendations of NRC GL 88-01 provide timely detection of cracks and leakage of coolant. Based on inspection results, NRC GL 88-01 provides guidelines for additional samples of welds to be inspected when one or more cracked welds are detected in a weld category.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
The NRC GL 88-01 recommends that any indication detected be evaluated in accordance with the requirements of ASME Code, Section XI, Subsection IWB-3640.		
6.1: (NMP-1 plant visit) The NRC GL 88-01 recommends	The applicant has rightfully pointed out that the GL 88-01	Revise

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
that any indication detected be evaluated in accordance with the requirements of ASME Section XI, Subsection IWB-3640. However, although the GL 88-01 refers to 1986 edition of the Code, the GALL reports have a footnote regarding the edition of the Code, and include the 1995 to 2004 editions as modified and limited in 10 CFR 50.55a. The applicant has to justify the use of any other Code edition.	refers to 1986 edition of the ASME Code, whereas GALL, Rev. 0, refers to the 1995 edition. The NMP-1 makes an exception to the GALL AMP, and flaw indications are evaluated in accordance with IWB-3640 of the ASME Code Section XI, 1989 edition. For such cases where the guidance in the supporting document is based on earlier edition of the ASME Code than referenced in the GALL report, it would be useful to provide clarification about whether the earlier edition of the Code is acceptable, so that the applicants do not have to make exceptions.	element 4 of the AMP to include clarification.
7. Corrective Actions		
The guidance for weld overlay repair, stress improvement, or replacement is provided in NRC GL 88-01. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
The IGSCC has occurred in small- and large-diameter boiling water reactor (BWR) piping made of austenitic stainless steels. The		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
comprehensive program outlined in NRC GL 88-01 and NUREG-0313 addresses improvements in all that cause SCC or IGSCC (e.g., susceptible material, significant tensile stress, and an aggressive environment) and is effective in managing IGSCC in austenitic SS piping in the RWCU system.		
10.1: No significant concern or further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a The American Society of Mechanical Engineers, New York, NY.

NRC Letter from Joseph W. Shea, U.S. Nuclear Regulatory Commission, to George A. Hunger, Jr., PECO Energy Company, *Reactor Water Cleanup (RWCU) System Weld Inspections at Peach Bottom Atomic Power Station*, *Units 2 and 3 (TAC Nos. M92442 and M92443)*, September 15, 1995. (ADAMS Accession Number ML090930466)

NRC Letter from Robert M. Pulsifer, U.S. Nuclear Regulatory Commission, to Michael A Balduzzi, Vermont Yankee Nuclear Power Corporation, *Review of Request to Discontinue Intergranular Stress Corrosion Cracking Inspection of RWCU Piping Welds Outboard of the Second Containment Isolation Valves (TAC No. MB0468),* March 27, 2001. (ADAMS Accession Number ML010780094)

NRC Generic Letter 88-01, *NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping,* U.S. Nuclear Regulatory Commission, January 25, 1988.

NRC Generic Letter 88-01, Supplement 1, *NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping,* U.S. Nuclear Regulatory Commission, February 4, 1992.

NRC Generic Letter 89-10, *Safety-related Motor Operated Valve Testing and Surveillance,* U.S. Nuclear Regulatory Commission, June 28, 1989; through Supplement 7, January 24, 1996.

NUREG-0313, Rev. 2, *Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping,* W. S. Hazelton and W. H. Koo, U.S. Nuclear Regulatory Commission, 1988.

A.25 XI.M26 Fire Protection

The verbatim text of GALL, Rev. 2, AMP XI.M26, Fire Protection (FP), is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item that is based on the visit to the visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
For operating plants, the Fire Protection aging management program (AMP) includes a fire barrier inspection program. The fire barrier inspection program requires periodic visual inspection of fire barrier penetration seals; fire barrier walls, ceilings, and floors; and periodic visual inspection and functional tests of fire-rated doors to ensure that their operability is maintained. The AMP also includes periodic inspection and testing of the halon/carbon dioxide (CO2) fire suppression system.		
a.1: (Ginna plant visit) Ginna FP AMP includes aging management of fire break, fire wraps, and fire pump performance tests.	The program description should be expanded to include aging management of fire break, fire wraps, and fire pump performance tests.	Revise program description.
a.2: (NMP-1 plant audit) NMP-1 is in transition from the deterministic-based 10 CFR 50, Appendix R, fire protection to the risk-based NFPA 805. The NFPA 805 risk-based fire protection has been endorsed by NRC and some plants have already transitioned to the NFPA 805 fire protection program.	It is recommended to expand the program description to include plant fire protection program based on the risk-based NFPA 805. This may impact intervals of inspection and testing and other factors such as locations for inspection.	Revise program description.
Program Basis Documents and/or Supporting Documents		
The GALL AMP states that visual inspection of walkdown is performed at a frequency in accordance with an NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program). The risk-based NFPA 805 is also an NRC-approved fire protection program and needs to be addressed in the AMP.		
b.1: (NMP-1 plant audit) NMP-1 is in transition from deterministic-based Appendix R to risk-based NFPA 805. However, the NMP-1 program basis documents and/or supporting documents do not include NFPA 805 and related NRC Regulatory Guides such as Regulatory Guide	Include the program description of NFPA 805 and NRC Regulatory Guides related to NFPA 805, such as: Regulatory Guide 1.205, Revision 1, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water	Revise or update program description.

[1] Proposed NRC action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1.205 and 1.189. The scope of inspection and inspection intervals based on NFPA 805 may be different from these based on Appendix R.	Nuclear Power Plants," Dec. 2009. Regulatory Guide 1.189, "Fire Protection for Nuclear Power Plants," Oct. 2009.	
Program Consistency and Commitments		
NMP-1 has the following commitments in SER Appendix A prior to the PEO: (1) Incorporate periodic visual inspections of piping and fittings in a non-water environment (e.g., halon) and CO_2 fire suppression system components to detect evidence of corrosion and any system mechanical damage that could affect its intended function. (2) Expand the scope of periodic functional tests of the diesel-driven fire pump to include inspection of engine exhaust system components to verify that loss of material is managed. (3) Perform an engineering evaluation to determine the plant-specific inspection frequency of fire doors. (4) Revise Halon and CO_2 functional test frequencies to semi-annual. The NMP-1 Fire Protection Program makes an exception to the GALL Report "detection of aging effects" program element where it requires bi-monthly inspection of hollow metal fire doors and monthly inspection of the halon/carbon dioxide suppression system valve lineup. Staff reviewed the exceptions in the SER and found these exceptions are acceptable because NMP-1 followed the guidelines in ISG-04 "Aging Management of Fire Protection Systems for License Renewal," on both exceptions.		
c.1: The GALL AMR table does not include fire pump exhaust system components.	It is recommended including loss of material due to corrosion of fire pump exhaust system components in the fire protection AMR Table and the AMP.	Update AMP program element and AMR table.
1. Scope of Program		
This program manages the effects of loss of material and cracking, increased hardness, shrinkage and loss of strength on the intended function of the penetration seals; fire barrier walls, ceilings, and floors; other fire resistance materials (e.g., flamastic, 3M fire wrapping, spray-on fire proofing material, intumescent coating, etc.) that serve a fire barrier function; and all fire-rated doors (automatic or manual) that perform a fire barrier function. It also manages the aging effects on the intended function of the halon/CO2 fire suppression system.		
1.1: (Ginna plant audit) The Ginna Fire Protection AMP includes aging management of fire break, fire wraps, and grout. These items are passive components that are not included in the GALL.	The fire break (fire stop) limits flame propagation along vertical or horizontal cable tray runs; fire wrap is heat-resistant covering (Hymec Wrap) to protect safe shutdown circuits. These are important fire protection components.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	Flame resistance of a cable is frequently defined as the ability to stop burning once the source of heat is removed. Test methods such as IEEE-383 have been developed to measure the flame resistance of wire and cable products (add IEEE-383 reference).	
1.2: (Ginna plant audit) The Ginna Fire Protection AMP includes a diesel-driven fire pump performance test that is not included in GALL 2. Diesel-driven fire pump performance test and inspection of the fuel oil supply line were deleted from the scope of Fire Protection AMP of GALL 2 because the diesel-driven fire pump fuel oil supply line is managed by the Fuel Oil Analysis and the One-Time Inspection Programs as accepted by NRC staff in numerous LR SERs (NUREG-1950).	The Ginna FP AMP includes periodic testing of fire pumps. The Ginna AMP states that: "Periodic testing of the motor and diesel-driven fire pumps ensures that adequate flow of firewater is supplied and that there is no degradation of diesel fuel lines to the diesel fire pump." "Two redundant, full capacity fire pumps, one electric-motor driven and one diesel driven, with independent power supplies and controls are provided. The fuel supply tank for the diesel driven fire pump contains an eight hour minimum fuel supply." STP-O-13: "Performance test is performed monthly to verify the standby operability of the diesel engine-driven and electric motor-drive fire pumps." "Periodic testing of the fire pumps provided data and trending to justify replacement of Diesel fire pump engine in 1994 and replacement of both pump assemblies in 2002 and 2003 to address wear-related impeller and column pipe issue." Based on the above statements, the following is recommended in subsequent license renewal AMPs: (a) Put back the periodic diesel fire pump performance testing in GALL. Fuel Oil Analysis and one-time inspection cannot assure "adequate" flow of water is supplied, and they cannot detect aging effects such as the impeller wear that resulted in replacement of the diesel fire pump in 1994 and pump assemblies (both diesel and electric-motor driven pump) in 2002 and 2003. Since impeller wear of the electric-motor driven fire pump also occurred, periodic testing of the electric	Revise or update element 1 of the AMP to include diesel-driven fire pump performance tests and diesel fuel tanks in the AMR table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	fire pump should also be included in the AMP. During the interview, FP AMP program owners confirmed that Ginna is still continuing to test the fire pumps (along with pump oil collection tank RCPs) and it is their opinion that the test results suggest that it is necessary to include testing of the fire pumps in for subsequent license renewal. (b) Add "diesel fuel tanks" in the AMR table. GALL has only a line item for piping, piping components, and piping elements in the fuel oil environment. It does not include diesel fuel oil tanks.	
2. Preventive Actions		
This is a condition monitoring program. However, the fire hazard analysis assesses the fire potential and fire hazard in all plant areas. It also specifies measures for fire prevention, fire detection, fire suppression, and fire containment and alternative shutdown capability for each fire area containing structures, systems, and components important to safety.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
Visual inspection of not less than 10% of each type of penetration seal is performed during walkdowns. These inspections examine any sign of degradation, such as cracking, seal separation from walls and components, separation of layers of material, rupture and puncture of seals that are directly caused by increased hardness, and shrinkage of seal material due to loss of material. Visual inspection of the fire barrier walls, ceilings, and floors and other fire barrier materials detects any sign of degradation, such as cracking, spalling, and loss of material caused by freeze-thaw, chemical attack, and reaction with aggregates that could affect their intended fire protection function. Fire-rated doors are visually inspected to detect any degradation of door surfaces. The periodic visual inspection and function test are performed to examine for signs of corrosion that may lead to the loss of material of the halon/CO2 fire suppression system.		
3.1: (Ginna LRA) The Ginna Fire Protection AMP includes aging management of fire break, fire wraps, and grout. These items are passive components that are not included in GALL. Expanding materials and aging effects requiring	The parameters monitored/inspected for fire stops and fire wraps are provided below. **Material/ Environment** **AERM**	Revise or update the AMP to include parameters

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
management (AERM) line items (a significant number of those at Ginna were not included in GALL 2001 or GALL 2010, such as fire stops and fire wraps).	Fire stop material/indoor (no air conditioning) Cracking/delamination due to movement Cracking/delamination due to shrinkage Cracking/delamination due to vibration Hardening and shrinkage due to weathering Loss of material Separation due to movement Separation due to shrinkage Separation due to vibration Fire wrap material/indoor (no air conditioning) Cracking/delamination due to movement Cracking/delamination due to vibration Loss of material Grout/indoor (no air conditioning) Cracking/delamination due to movement Cracking/delamination due to shrinkage Cracking/delamination due to vibration Hardening and shrinkage due to weathering Separation due to movement Separation due to shrinkage Separation due to vibration Structural steel-stainless/indoor (no air conditioning) No aging effect	monitored/inspected for fire stops and fire wraps.
3.2: (Ginna plant audit) Impeller wear of the electric-motor	**3.2:** Add impeller wear of fire pumps in the parameters	Revise the

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
driven fire pump occurred in the Ginna plant.	monitored/inspected program element based on the operating experience of Ginna.	AMP program element.
4. Detection of Aging Effects		
Visual inspection of penetration seals detects cracking, seal separation from walls and components, and rupture and puncture of seals. Visual inspection by fire protection qualified personnel of not less than 10% of each type of seal in walkdowns is performed at a frequency in accordance with an NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program, etc.) or at least once every refueling outage. If any sign of degradation is detected within that sample, the scope of the inspection is expanded to include additional seals. Visual inspection by fire protection qualified personnel of the fire barrier walls, ceilings, floors, doors, and other fire barrier materials performed in walkdowns at a frequency in accordance with an NRC-approved fire protection program ensure timely detection of concrete cracking, spalling, and loss of material. Visual inspection by fire protection qualified personnel detects any sign of degradation of the fire doors, such as wear and missing parts. Periodic visual inspection and function tests detect degradation of the fire doors before there is a loss of intended function. Visual inspections of the halon/CO2 fire suppression system are performed to detect any sign of corrosion. The periodic functional test is performed at least once every 6 months or on a schedule in accordance with an NRC-approved fire protection program. Inspections are performed to detect degradation of the halon/CO2 fire suppression system before the loss of the component intended function.		
4.1: (NMP-1 plant audit) The GALL states that visual inspection of seals is performed at a frequency in accordance with an NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program) or at least once every refueling outage. GALL also states that the periodic functional test of halon/CO_2 fire suppression system is performed at least once every 6 months or on a schedule in accordance with an NRC-approved fire protection program. NMP-1 is in transition from the deterministic-based Appendix R program to the risk-based NFPA 805 program. The Risk-Informed, Performance-Based Fire Protection based on NFPA 805 has been endorsed by NRC, and some plants have already completed the transition. The GALL report, however, has not taken into consideration of the risk-based NFPA 805 program.	The program element should be expand to include NFPA 805 in the NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program) and provide guidelines in the AMP based on NFPA 805 and Regulatory Guides related to NFPA 805, such as: Regulatory Guide 1.205, Revision 1, “Risked-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants,” Dec. 2009. Regulatory Guide 1.189 “Fire Protection for Nuclear Power Plants,” Oct. 2009. Fire protection based on NFPA 805 may have significant impact on inspection scope and inspection frequencies on the fire protection aging management.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4.2: No further review item was identified.		
5. Monitoring and Trending		
The results of inspections of the aging effects of cracking, spalling, and loss of material on fire barrier penetration seals, fire barriers, and fire doors are used to trend future actions. The performance of the halon/CO2 fire suppression system is monitored during the periodic test to detect any degradation in the system. These periodic tests provide data necessary for trending.		
5.1: (Ginna plant audit) The trending report and system health report of the Ginna Fire Protection AMP are available at Ginna on quarterly basis. The quarterly trending is considered to be a good practice and should be recommended in GALL. (Note: one area that can be improved in the Ginna trending and health report is to differentiate between "no problem found in this period" based on inspection results or because no inspection was conducted in this quarterly period.) (NMP-1 plant audit) NMP-1 does not perform trending and has no trending report. This is a shortcoming in the NMP-1 FPP. GALL should emphasize importance of trending.	GALL program elements should emphasize the importance of trending and recommend that trending reports be prepared on a quarterly basis.	Revise or update the AMP program element.
6. Acceptance Criteria		
Inspection results are acceptable if there are no signs of degradation that could result in the loss of the fire protection capability due to loss of material. The acceptance criteria include (a) no visual indications (outside those allowed by approved penetration seal configurations) of cracking, separation of seals from walls and components, separation of layers of material, or ruptures or punctures of seals; (b) no significant indications of concrete cracking, spalling, and loss of material of fire barrier walls, ceilings, and floors and in other fire barrier materials; (c) no visual indications of missing parts, holes, and wear; and (d) no deficiencies in the functional tests of fire doors. Also, no indications of excessive loss of material due to corrosion in the halon/CO2 fire suppression system are acceptable.		
6.1: No further review item was identified.		
7. Corrective Actions		
For fire protection structures and components identified that are subject to an AMR for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for corrective actions, confirmation process, and administrative controls for aging management during the period of extended operation. This corrective action program is documented in the final safety analysis report supplement in accordance with 10 CFR 54.21(d). As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
to address the corrective actions, confirmation process, and administrative controls.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Silicone foam fire barrier penetration seals have experienced splits, shrinkage, voids, lack of fill, and other failure modes (U.S. Nuclear Regulatory Commission [NRC] Information Notice [IN] 88-56, IN 94-28, and IN 97-70). Degradation of electrical raceway fire barrier such as small holes, cracking, and unfilled seals are found on routine walkdown (NRC IN 91-47 and NRC Generic Letter 92-08). Fire doors have experienced wear of the hinges and handles.		
10.1: (Ginna) Additional equipment was added to the list of safe-shutdown components to account for the effects of increased decay heat due to power upgrade. There was no impact of EPU on the fire protection AMP. The FPP will continue to meet the requirements of 10 CFR 50.48, Appendix R to 10 CFR 50, and GDCs 3 and 5 following implementation of the proposed EPU.	The EPU could have significant impact on various auxiliary systems, such as adding additional safety equipment to account for the effects of increased decay heat due to power upgrade. It may also affect the plant fire protection systems. GALL may request the applicant to address OE on the effects of power upgrades on aging management of fire protection systems.	Revise or update the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Generic Letter 92-08, *Thermo-Lag 330-1 Fire Barrier*, U.S. Nuclear Regulatory Commission, December 17, 1992.

NRC Information Notice 88-56, *Potential Problems with Silicone Foam Fire Barrier Penetration Seals*, U.S. Nuclear Regulatory Commission, August 14, 1988.

NRC Information Notice 91-47, *Failure of Thermo-Lag Fire Barrier Material to Pass Fire Endurance Test*, U.S. Nuclear Regulatory Commission, August 6, 1991.

NRC Information Notice 94-28, *Potential Problems with Fire-Barrier Penetration Seals*, U.S. Nuclear Regulatory Commission, April 5, 1994.

NRC Information Notice 97-70, *Potential Problems with Fire Barrier Penetration Seals*, U.S. Nuclear Regulatory Commission, September 19, 1997.

Additional References

10 CFR 50 Appendix R, *Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.48, *Fire Protection,* Office of the Federal Register, National Archives and Records Administration, 2007.

NRC Generic Letter 86-10, *Implementation of Fire Protection Requirements*, U.S. Nuclear Regulatory Commission, April 24, 1986.

NRC Generic Letter 86-10, Suppl. 1, Fire Endurance Test Acceptance Criteria for Fire Barrier Systems Used to Separate Redundant Safe Shutdown Trains Within the Same Fire Area, U.S. Nuclear Regulatory Commission, March 25, 1994.

NRC Regulatory Guide 1.189, *Fire Protection for Nuclear Power Plants,* (ML092580550), U.S. Nuclear Regulatory Commission, October 2009.

A.26 XI.M27 Fire Water System

The verbatim text of GALL, Rev. 2, AMP XI.M27, Fire Water System, is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This aging management program (AMP) applies to water-based fire protection systems that consist of sprinklers, nozzles, fittings, valves, fire pump casings, hydrants, hose stations, standpipes, water storage tanks, and aboveground, buried, and underground piping and components that are tested in accordance with the applicable National Fire Protection Association (NFPA) codes and standards. Such testing assures the minimum functionality of the systems. Also, these systems are normally maintained at required operating pressure and monitored such that loss of system pressure is immediately detected and corrective actions initiated. A sample of sprinkler heads is tested by using the guidance of NFPA 25, “Inspection, Testing and Maintenance of Water-Based Fire Protection Systems” (1998 Edition), Section 2-3.1.1, or NFPA 25 (2002 Edition), Section 5.3.1.1.1. These NFPA sections state “where sprinklers have been in place for 50 years, they shall be replaced or representative samples from one or more sample areas shall be submitted to a recognized testing laboratory for field service testing.” It also contains guidance to perform this sampling every 10 years after the initial field service testing. The water-based fire protection system piping is subjected to required flow testing in accordance with guidance in NFPA 25 to verify design pressure or evaluated for wall thickness (e.g., non-intrusive volumetric testing or plant maintenance visual inspections) to ensure that aging effects are managed and that wall thickness is within acceptable limits. These inspections are performed before the end of the current operating term and at plant-specific intervals thereafter during the period of extended operation. The plant-specific inspection intervals are determined by engineering evaluation of the fire protection piping to ensure that degradation is detected before the loss of intended function. The purpose of the full flow testing and wall thickness evaluations is to ensure that corrosion, microbiologically influenced corrosion (MIC), or biofouling is managed such that the system function is maintained. Chapter XI.M41 describes the aging management program for buried and underground water-based fire protection system piping and tanks.		
a.1: (NMP-1 plant visit) SER 3.3 B.2.3.13: Site procedure S CTP V632, "Sampling and Analysis of Water Systems for Bacteria," is credited with managing loss of material due to	Add the following statements for plants using raw water, such as lake or sea water, as a water source as opposed to city water:	Revise program description.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
microbiological activity. The procedure provides for sampling and analysis of raw water systems for the presence of bacteria. In addition, as presented in original LRA Sections A1.1.18 and B2.1.17, the Fire Water System Program will be enhanced prior to the period of extended operation to add specific requirements for periodic sampling of water-based fire protection systems. The GALL AMP may need to include periodic sampling and analysis for the presence of bacteria in the fire water systems using raw water as a water source.	For plants using raw water, such as lake or sea water, as a water source, the program consists of periodic sampling and analysis of water systems for the presence of bacteria and microbiological contamination.	
a.2: (Ginna plant audit) The program description mentions water storage tanks; however, the AMR line item VII.G.A-33 only contains "piping, piping components, and piping systems" with a raw water environment. Ginna performs inspection once every 3 years on fire water storage tanks. During the 2004 inspection, 32 coating failures were found in the interior of the fire storage water tank.	Change AMR line item VII.G.A-33 to: "piping, piping components, piping elements, and water storage tanks."	Revise or update program description.
a.3: (Ginna plant audit) As mentioned in the program description, Chapter XI.M41 describes the AMP for buried and underground water-based fire protection system piping and tanks. However, the GALL XI.M41 program does not address selective leaching (i.e., graphitization of cast iron piping and components in wet acidic soil) that might occur to the buried fire water systems. For subsequent license renewal, the program description should also note that the GALL XI.M33 "Selective Leaching of Materials" program should be used in addition to XI.M41 for applicable materials and environments.	Expand the program description as follows: Chapter XI.M41 describes the AMP for buried and underground water-based fire protection system piping and tanks. <u>Selective leaching (i.e., graphitization of cast iron piping and components in wet acidic soil) could occur to the buried fire-water systems in wet acidic soil. The Chapter XI.M33 "Selective Leaching of Materials" program should be also used in addition to XI.M41 for aging management of buried fire water systems.</u>	Revise or update program description.
Program Basis Documents and/or Supporting Documents		
NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, 2002 Edition, National Fire Protection		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Association.		
b.1: No further review item was identified.		
Program Consistency and Commitments		
Ginna is committed to implement the following items prior to the PEO in SER Appendix A: (1) Replace or test a representative sample of fire water system sprinklers that have been in service for up to 50 years. (2) Define selection criteria, sample size, and periodicity of inspections for fire system piping. (3) Add fire service water (SW) booster pump and associated valves and piping back to the SW system into the scope of license renewal. NMP-1 is committed to implement the following items prior to the PEO in SER Appendix A: (1) Incorporate inspections to detect and manage loss of material due to corrosion into existing periodic test procedures. (2) Specify periodic component inspections to verify that loss of material is being managed. (3) Add procedural guidance for performing visual inspections to monitor internal corrosion and detect biofouling. (4) Add requirements to periodically check the water-based fire protection systems for microbiological contamination. (5) Measure fire protection system piping wall thickness using non-intrusive techniques (volumetric testing) to detect loss of material due to corrosion. (6) Establish an appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and volumetric testing. (7) Define acceptance criteria for visual inspections and volumetric testing. (8) Develop new procedures and preventative maintenance tasks to implement sprinkler head replacements and/or inspections to satisfy NFPA 25, Section 5.3.1.		
c.1: GALL fire protection AMR table does not include fire SW booster pump and associated valves and piping.	It is recommended including fire SW booster pump and associated valves and piping in Fire Protection AMR table.	Update the AMR table.
1. Scope of Program		
The AMP focuses on managing loss of material due to corrosion, MIC, or biofouling of steel components in fire protection systems exposed to water. Fire hose stations and standpipes are considered as piping in the AMP. Fire hoses and gaskets can be excluded from the scope of license renewal if the standards that are relied upon to prescribe replacement of the hose and gaskets are identified in the scoping methodology description.		
1.1: The GALL AMP states that this AMP manages loss of material due to corrosion, MIC, or biofouling of steel components in the fire protection system exposed to water. It is not clear how the aging degradation is managed for	Add guidance on aging management of portions of the fire water system that are made of other materials, such as brass, cement, or PVC, and the normally dry portions of the fire water system such as the yard nozzle and dry piping.	Update or revise the program description

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
components in the fire water system that are made of other materials, such as brass, cement, or PVC. A statement in the scope of program or program description may be helpful. A large fraction of the fire water system is normally dry and not exposed to indoor or outdoor air. The yard nozzles are normally open and the dry piping between the nozzles and the supply valve collect dust or other pollutants. These lines get wet when flow tested, which can cause corrosion and other problems. As written, XI.M27 seems to suggest that only the system exposed to water is covered by the program. There should be clear guidance regarding the aging management of the normally dry portions of the fire water system.		and program elements as appropriate.
2. Preventive Actions		
To ensure that no significant corrosion, MIC, or biofouling has occurred in water-based fire protection systems, periodic flushing and system performance testing are conducted in accordance with NFPA 25.		
2.1: (NMP-1 plant audit) NMP-1 replaced CS piping with SS and the diameter was increased. What was previously 1.5-inch diameter CS piping was replaced with 2-inch SS piping.	Recommend replacing CS piping with SS piping and increasing piping size as preventive actions for corrosion and bio-fouling.	Update the AMP program element.
3. Parameters Monitored/Inspected		
Loss of material due to corrosion and biofouling could reduce wall thickness of the fire protection piping system and result in system failure. Therefore, the parameters monitored are the system's ability to maintain pressure and internal system corrosion conditions. Periodic flow testing of the fire water system is performed using the guidelines of NFPA 25, or wall thickness evaluations may be performed to ensure that the system maintains its intended function. Testing of sprinklers ensures that degradation is detected in timely manner.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
The water-based fire protection system testing is performed to ensure that the system functions by maintaining required operating pressures. Wall thickness evaluations of fire protection piping are performed on system components using non-intrusive techniques (e.g., volumetric testing) to identify evidence of loss of material due to corrosion. These inspections are performed before the end of the current		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
operating term and at plant-specific intervals thereafter during the period of extended operation. As an alternative to non-intrusive testing, the plant maintenance process may include a visual inspection of the internal surface of the fire protection piping upon each entry to the system for routine or corrective maintenance, as long as it can be demonstrated that inspections are performed (based on past maintenance history) on a representative number of locations on a reasonable basis. These inspections are capable of evaluating (a) wall thickness to ensure against catastrophic failure and (b) the inner diameter of the piping as it applies to the design flow of the fire protection system. If the environmental and material conditions that exist on the interior surface of the below grade fire protection piping are similar to the conditions that exist within the above grade fire protection piping, the results of the inspections of the above grade fire protection piping can be extrapolated to evaluate the condition of below grade fire protection piping. If not, additional inspection activities are needed to ensure that the intended function of below grade fire protection piping is maintained consistent with the current licensing basis for the period of extended operation. Continuous system pressure monitoring, system flow testing, and wall thickness evaluations of piping are effective means to ensure that corrosion and biofouling are not occurring and that the system's intended function is maintained. General requirements of existing fire protection programs include testing and maintenance of fire detection and protection systems and surveillance procedures to ensure that fire detectors as well as fire protection systems and components are operable. Visual inspection of yard fire hydrants, performed annually in accordance with NFPA 25, ensures timely detection of signs of degradation, such as corrosion. Fire hydrant hose hydrostatic tests, gasket inspections, and fire hydrant flow tests, performed annually, ensure that fire hydrants can perform their intended function and provide opportunities to detect degradation before a loss of intended function can occur. Sprinkler heads are tested before the end of the 50-year sprinkler head service life and at 10-year intervals thereafter during the period of extended operation to ensure that signs of degradation, such as corrosion, are detected in a timely manner.		
4.1: (NMP-1 plant audit) NMP-1 is committed to implementing the following item prior to the PEO: Add requirements to periodically check the water-based fire protection systems for microbiological contamination. The GALL AMP needs to include this requirement.	The following statement should be added: Periodic sampling and analysis is performed on the raw-water-based fire protection systems to detect the presence of bacteria and microbiological contamination.	Update or revise the AMP program element.
5. Monitoring and Trending		
System discharge pressure is monitored continuously. Results of system performance testing are monitored and trended as specified by the associated plant commitments pertaining to NFPA codes and standards. Degradation identified by non-intrusive or visual inspection is evaluated.		
5.1: NMP-1 is committed to implemented the following item prior	Enhance the program element as follows:	Update or

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
to the PEO: Establish an appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and volumetric testing.	System discharge pressure is monitored continuously. Results of system performance testing are monitored and trended as specified by the associated plant commitments pertaining to NFPA codes and standards. Degradation identified by non-intrusive or visual inspection is evaluated and trended. An appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and volumetric testing is established.	revise the AMP program element.
6. Acceptance Criteria		
The acceptance criteria are (a) the water-based fire protection system is able to maintain required pressure, (b) no unacceptable signs of degradation are observed during non-intrusive or visual inspection of components, (c) minimum design pipe wall thickness is maintained, and (d) no biofouling exists in the sprinkler systems that could cause corrosion in the sprinklers.		
6.1: No further review item was identified.		
7. Corrective Actions		
Repair and replacement actions are initiated as necessary. For fire water systems and components identified within scope that are subject to an aging management review (AMR) for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for corrective actions for aging management during the period of extended operation. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
For fire water systems and components identified within scope that are subject to an AMR for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for confirmation process for aging management during the period of extended operation. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
For the water-based fire water systems and components identified within scope that are subject to an AMR for license renewal, the applicant's 10 CFR Part 50, Appendix B, program is used for administrative controls for aging management during the period of extended operation. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
9.1: No further review item was identified.		
10. Operating Experience		
Water-based fire protection systems designed, inspected, tested, and maintained in accordance with the NFPA minimum standards have demonstrated reliable performance.		
10.1: (Ginna and NMP-1 plant audit) The GALL AMP does not contain examples of degradation of fire water systems. For example**,** Ginna performs inspection every 3 years on fire water storage tanks. During the 2004 inspection, 32 areas of coating failures were found in the interior of the fire storage water tank. NMP-1 Condition reports (CRs) include: (a) Obstructions in fire system piping due to corrosion products or lake water silt (one CR in 2005), (b) through-wall leaks of FP piping (4 CRs in 2002-2004), (c) UT readings of FP piping below minimum wall thickness (7 CRs), and (d) tuberculation has been observed in branch piping in the flow tests.	The following is recommended: (a) Adding the Ginna and NMP-1 CR cases in the operating experience, and (b) addressing tuberculation in the program. Tuberculation is a degradation condition that develops on the interior of pipelines due to corrosive materials present in the water passing through the pipe and results in the creation of small, hemispherical lumps (tubercles) on the walls of the pipe, which increase friction loss and reduce flow velocity.	Update or revise the AMP program element.
10.2: (NMP-1 plant audit) NMP-1 engineers believe that the life of Victaulic joints may be the major issue of the fire water system for subsequent renewal. Tuberculation has been observed in branch piping in the NMP-1 flow tests. Currently in NUREG-1801, Rev. 2, only 5 out of 1520 AMR line items are based on XI.M27. Based on operating with tuberculation and Victaulic seals, these may need more attention.	Add tuberculation as an aging mechanism for fire water piping and add Victaulic seals and related components in the AMR table. Also add aging management due to tuberculation and Victaulic seals in the AMP program elements as appropriate.	Update or revise the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, 1998 Edition, National Fire Protection Association.

NFPA 25, *Inspection, Testing and Maintenance of Water-Based Fire Protection Systems*, 2002 Edition, National Fire Protection Association.

A.27 XI.M29 Aboveground Metallic Tanks

The verbatim text of GALL, Rev. 2, AMP XI.M29, Aboveground Metallic Tanks, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The Aboveground Metallic Tanks aging management program (AMP) manages the effects of loss of material on the outer surfaces of above ground tanks constructed on concrete or soil. If the tank exterior is fully visible, the program for inspection of external surfaces may be used instead (XI.M36). This program credits the standard industry practice of coating or painting the external of steel tanks as a preventive measure to mitigate corrosion. The program relies on periodic inspections to monitor degradation of the protective paint or coating. However, for storage tanks supported on earthen or concrete foundations, corrosion may occur at inaccessible locations, such as the tank bottom. Accordingly, verification of the effectiveness of the program is performed to ensure that significant degradation in inaccessible locations is not occurring and that the component intended function is maintained during the period of extended operation. For reasons set forth below, an acceptable verification program consists of thickness measurement of the tank bottom surface.		
a.1: No further review item was identified.		
Program Basis Documents and/or Supporting Documents		
NRC Generic Letter 98-04; NRC Information Notice 89-79; IN 89-79, Supplement 1; IN 86-99; and IN 86-99, Supplement 1.		
b.1: No further review item was identified.		
Program Consistency and Commitments		
The AMP for both Ginna and NMP-1 plants is consistent with the GALL, Rev. 0, AMP XI.M29, Aboveground Metallic Tanks, and there are no commitments in the SER for this program.		
c.1: No further review item was identified.		
1. Scope of Program		
The program consists of periodic inspections of metallic tanks (with or without coatings) to manage the effects of corrosion on the intended function of these tanks. Inspections cover the entire outer surface of the tank. Because lower portions of the tank are on concrete or soil, this program includes the bottom of the tank as well. If the tank exterior is fully visible, the program for inspection of external surfaces may		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
be used instead (AMP XI.M36).		
1.1: No further review item was identified.		
2. Preventive Actions		
In accordance with industry practice, tanks may be coated with protective paint or coating to mitigate corrosion by protecting the external surface of the tank from environmental exposure. Sealant or caulking may be applied at the external interface between the tank and concrete or earthen foundation to mitigate corrosion of the bottom surface of the tank by minimizing the amount of water and moisture penetrating the interface, which would lead to corrosion of the bottom surface.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
The AMP utilizes periodic plant inspections to monitor degradation of coatings, sealants, and caulking because it is a condition directly related to the potential loss of materials. Additionally, thickness measurements of the bottoms of the tanks are made periodically for the tanks monitored by this program as an additional measure to ensure that loss of material is not occurring at locations that are inaccessible for inspection.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
Degradation of an exterior metallic surface can occur in the presence of moisture; therefore, an inspection of the coating is performed to ensure that the surface is protected from moisture. Conducting periodic visual inspections at each outage to confirm that the paint, coating, sealant, and caulking are intact is an effective method to manage the effects of corrosion on the external surface of the component. Potential corrosion of tank bottoms is determined by taking ultrasonic testing (UT) thickness measurements of the tank bottoms whenever the tank is drained and at least once within 5 years of entering the period of extended operation. Measurements are taken to ensure that significant degradation is not occurring and that the component intended function is maintained during the period of extended operation.		
4.1: (Ginna plant staff audit report) The exterior surfaces of the tanks are visually inspected by the system engineers periodically. AMP XI.M29 should include a statement that inspections of the tanks should be conducted by structural engineers qualified to monitor structures and components for applicable aging effects, or inspectors qualified in accordance with ASME code for VT1 and VT3	Add a statement to the AMP that inspections of the tanks should be conducted by structural engineers qualified to monitor structures and components for applicable aging effects, or inspectors qualified in accordance with ASME code for VT1 and VT3 examinations.	Update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
examinations.		
4.2: (Ginna plant staff audit report) One-time inspection of UT measurement prior to the PEO found significant loss of thickness at the tank bottom due to corrosion; however, no follow-up examinations are scheduled. GALL recommends thickness measurement of tank bottoms at least once within 5 years. For tank bottoms with significant corrosion more frequent thickness measurements may be required.	Add a statement that for tank bottoms with significant corrosion, thickness measurements may be required more frequently than every 5 years.	Update the AMP program element.
5. Monitoring and Trending		
The effects of corrosion of the aboveground external surface are detectable by visual techniques. Based on operating experience, plant inspections during each outage provide for timely detection of aging effects. The effects of corrosion of the inaccessible external surface are detectable by UT thickness measurement of the tank bottom and are monitored and trended if significant material loss is detected where multiple measurements are available.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Any degradation of paints or coatings (cracking, flaking, or peeling) is reported and requires further evaluation. Drying, cracking, or missing sealant and caulking are unacceptable and need to be evaluated using the corrective action program. The evaluation will determine the need to repair the sealant and caulking. UT thickness measurements of the tank bottom are evaluated against the design thickness and corrosion allowance.		
6.1: No further review item was identified.		
7. Corrective Actions		
The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls. Flaws in the caulking or sealant are repaired.		
7.1: No further review item was identified.		
8. Confirmation Process		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Coating degradation, such as flaking and peeling, has occurred in safety-related systems and structures (U.S. Nuclear Regulatory Commission [NRC] Generic Letter 98-04). Corrosion damage near the concrete-metal interface and sand-metal interface has been reported in metal containments (NRC Information Notice [IN] 89-79; IN 89-79, Supplement 1; IN 86-99; and IN 86-99, Supplement 1).		
10.1: No further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Generic Letter 98-04, *Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment*, U.S. Nuclear Regulatory Commission, July 14, 1998.

NRC Information Notice 86-99, *Degradation of Steel Containments*, U.S. Nuclear Regulatory Commission, December 8, 1986.

NRC Information Notice 86-99, Supplement 1, *Degradation of Steel Containments*, U.S. Nuclear Regulatory Commission, February 14, 1991.

NRC Information Notice 89-79, *Degraded Coatings and Corrosion of Steel Containment Vessel*, U.S. Nuclear Regulatory Commission, December 1, 1989.

NRC Information Notice 89-79, Supplement 1, *Degraded Coatings and Corrosion of Steel Containment Vessel*, U.S. Nuclear Regulatory Commission, June 29, 1990.

A.28 XI.M30 Fuel Oil Chemistry

The verbatim text of GALL, Rev. 2, AMP XI.M30, Fuel Oil Chemistry, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program includes (a) surveillance and maintenance procedures to mitigate corrosion and (b) measures to verify the effectiveness of the mitigative actions and confirm the insignificance of an aging effect. Fuel oil quality is maintained by monitoring and controlling fuel oil contamination in accordance with the plant's technical specifications. Guidelines of the American Society for Testing Materials (ASTM) Standards, such as ASTM D 0975-04, D 1796-97, D 2276-00, D 2709-96, D 6217-98, and D 4057-95, also may be used. Exposure to fuel oil contaminants, such as water and microbiological organisms, is minimized by periodic draining or cleaning of tanks and by verifying the quality of new oil before its introduction into the storage tanks. However, corrosion may occur at locations in which contaminants may accumulate, such as tank bottoms. Accordingly, the effectiveness of the program is verified to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation. Thickness measurement of tank bottom surfaces is an acceptable verification program. The fuel oil chemistry program is generally effective in removing impurities from intermediate and high flow areas. This report identifies those circumstances in which the fuel oil chemistry program is to be augmented to manage the effects of aging for license renewal. For example, the fuel oil chemistry program may not be effective in low flow or stagnant flow areas. Accordingly, in certain cases as identified in this report, verification of the effectiveness of the chemistry program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation. As discussed in this report for these specific cases, an acceptable verification program is a onetime inspection of selected components at susceptible locations in the system.		
a.1: No specific concerns for LTO.		
Program Basis and Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in 10 CFR 50, Appendix B; ASTM Standards D 0975-04, D 1796-97, D 2276-00, D 2709-96, D 6217-98, and D 4057-95; and American Petroleum Institute (API) 653. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0. The Ginna LRA cites 10 CFR 50, Appendix B, and ASTM Standards D975, D1796, D2276, D4057, and D4176 in their Fuel Oil Chemistry AMP (B2.1.16). In the amended NMP-1 LRA, the Fuel Oil Chemistry Program (B2.1.18) cites ASTM Standards D975, D1796, D2276, and D4057. However, as noted in the Program Consistency and Commitments Section below, the NMP-1 LRA makes an exception to the use of ASTM D 2709, and both Ginna and NMP-1 make an exception to the use of the modified ASTM Standard D 2276.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
b.1: No specific concerns for LTO.		

Program Consistency and Commitments

The Ginna Fuel Oil Chemistry AMP (B2.1.16) lists no enhancements to GALL, Rev. 0, but lists two exceptions, namely Ginna (1) does not add biocides, stabilizers, or corrosion inhibitors to the fuel oil to mitigate corrosion; and (2) does not sample for particles in accordance with the modified ASTM D2276 test procedure. No commitments are identified in the LRA, but in the subsequent license renewal process, Ginna made a commitment to submit a technical specification change by the end of 2004, to incorporate specific particulate testing requirements for diesel generator fuel oil in accordance with the ASTM D2276 standard or its successor, and eliminate the need for the "clear and bright" method of the ASTM D4176 standard.

The NMP-1 Fuel Oil Chemistry Program AMP (B2.1.18) lists the following enhancements to GALL, Rev.0, and the program elements impacted:

Program Elements 1–5:

- Incorporate periodic tests for microbiological organisms at NMP-1.
- Provide guidelines for the appropriate use of biocides, corrosion inhibitors, and/or fuel stabilizers to maintain fuel oil quality.
-

Program Elements 2 and 4:

- Add requirements to periodically inspect the interior surfaces of the NMP-1 emergency diesel fuel oil tanks and diesel fire pump fuel oil day tank for evidence of significant degradation, including a specific requirement that the tank bottom thickness be determined.

Program Element 5:

- Add a requirement for quarterly trending of particulate contamination analysis results.

Program Element 6:

- Ensure acceptance criteria are specified in the implementing procedures for the applicable indications of potential degradation.

In addition, the NMP-1 AMP B2.1.18 made the following exceptions to GALL, Rev. 0, and the program elements impacted:

Program Elements 3 and 6:

- NMP-1 makes an exception to using both ASTM D 1796 and ASTM D2709 to determine the concentration of water and sediment in the diesel fuel oil tanks. NMP-1 uses only the guidance given in ASTM D1796. These standards are applicable to fuel oils of different viscosities. ASTM D 1796 is the standard that applies to the diesel fuel used at NMP-1.
- NMP-1 makes an exception to using the modified ASTM D 2276, Method A, which specifies a pore size of 3.0 µm. NMP-1 uses a filter with a pore size of 0.8 µm, as specified in ASTM D 2276.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Element 4: • NMP-1 makes an exception to multilevel sampling in the diesel fuel oil tanks. The physical configuration of the fuel oil tanks does not allow a representative fuel oil sample to be taken at multiple levels. Program Element 5: • NMP-1 makes an exception to periodically sampling the diesel fuel oil day tanks. These small tanks do not have a provision for sampling. Per Technical Specification Surveillance testing, the lower portion of the diesel fuel oil is drained quarterly in NMP-1. The following commitment (no. 21 on p. A1-40 of the amended NMP-1 LRA) is stated: "Enhance the Fuel Oil Chemistry Program to (1) Incorporate periodic tests for microbiological organisms (2) Provide guidelines for the appropriate use of biocides, corrosion inhibitors, and/or fuel stabilizers to maintain fuel oil quality (3) Add requirements to periodically inspect the interior surfaces of the emergency diesel fuel oil tanks and diesel fire pump fuel oil day tank for evidence of significant degradation, including a specific requirement that the tank bottom thickness be determined (4) Add a requirement for quarterly trending of particulate contamination analysis results and (5) Ensure acceptance criteria are specified in the implementing procedures for the applicable indications of potential degradation." This commitment is to be met prior to entering the period of extended operation. As a part of the license renewal process, NMP-1 stated that it would add an exception of the "detection of aging effects" program element of GALL, Rev. 0. NMP-1 makes an exception to performing internal inspections of any fuel oil tank. The applicant stated that after enhancement, all such tanks will be routinely drained; thereby removing any contaminants from the tank that would provide an aging mechanism. In addition, NMP-1 made minor revisions to some of the above enhancements to bring the AMP into conformance with GALL.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
Components within the scope of the program are the diesel fuel oil storage tanks, piping, and other metal components subject to aging management review that are exposed to an environment of diesel fuel oil. The program is focused on managing loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion (MIC) and fouling that leads to corrosion of the diesel fuel tank internal surfaces.		
1.1: No specific concerns for LTO.		
2. Preventive Actions		
The program reduces the potential for (a) exposure of the storage tanks' internal surface to fuel oil contaminated with water and microbiological organisms, reducing the potential for age-related degradation in other components exposed to diesel fuel oil; and (b) transport of corrosion products, sludge, or particulates to components serviced by the fuel oil storage tanks. Biocides or corrosion inhibitors may be added as a preventive measure or are added if periodic testing indicates biological activity or evidence of corrosion. Periodic cleaning of a tank allows removal of sediments, and periodic draining of water collected at the bottom of a tank minimizes the		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
amount of water and the length of contact time. Accordingly, these measures are effective in mitigating corrosion inside diesel fuel oil tanks. Coatings, if used, prevent or mitigate corrosion by protecting the internal surfaces of the tank from contact with water and microbiological organisms.		
2.1: Program Element 2 states, "coatings, if used, prevent or mitigate corrosion by protecting the internal surfaces of the tank from contact with water and microbiological organisms."	No further guidance is provided on types of coatings that are effective in controlling corrosion and are compatible with the fuel oil. In addition, no guidance is given on inspection techniques to verify the integrity of these coatings. An appropriate industry standard or other guidance is desirable here.	Consider providing additional guidance on use of coatings for corrosion protection.
3. Parameters Monitored/Inspected		
The program is focused on managing loss of material due to general, pitting, crevice, and MIC, and fouling that leads to corrosion of the diesel fuel tank internal surfaces. The aging management program monitors fuel oil quality through receipt testing and periodic sampling of stored fuel oil. Parameters monitored include water and sediment content, total particulate concentration, and the levels of microbiological organisms in the fuel oil. Water and microbiological organisms in the fuel oil storage tank increase the potential for corrosion. Sediment and total particulate content may be indicative of water intrusion or corrosion.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
Loss of material due to corrosion of the diesel fuel oil tank or other components exposed to diesel fuel oil cannot occur without exposure of the tank's internal surfaces to contaminants in the fuel oil, such as water and microbiological organisms. Periodic multilevel sampling provides assurance that fuel oil contaminants are below unacceptable levels. If tank design features do not allow for multilevel sampling, a sampling methodology that includes a representative sample from the lowest point in the tank may be used. At least once during the 10-year period prior to the period of extended operation, each diesel fuel tank is drained and cleaned, the internal surfaces are visually inspected (if physically possible) and volumetrically-inspected if evidence of degradation is observed during visual inspection, or if visual inspection is not possible. During the period of extended operation, at least once every 10 years, each diesel fuel tank is drained and cleaned, the internal surfaces are visually inspected (if physically possible), and, if evidence of degradation is observed during inspections, or if visual inspection is not possible, these diesel fuel tanks are volumetrically inspected. Prior to the period of extended operation, a one-time inspection (i.e., AMP XI.M32) of selected components exposed to diesel fuel oil is performed to verify the effectiveness of the Fuel Oil Chemistry program.		
4.1: AMP XI.M30, "Fuel Oil Chemistry" states under Program Element 4 that "Prior to the period of extended	The wording here should be clarified to indicate that this one-time inspection must be repeated prior to entering each	Revise wording of Program

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
operation, a one-time inspection (i.e., AMP XI.M32) of selected components exposed to diesel fuel oil is performed to verify the effectiveness of the Fuel Oil Chemistry program."	period of extended operation (i.e., another one-time inspection is required prior to subsequent license renewal).	Element 4.
4.2: Program Element 4 calls for direct visual inspection of the internal surfaces of the diesel fuel oil tanks at 10-year intervals during extended operation, beginning with an inspection performed sometime during the 10-year period prior to extended operation.	If significant degradation is detected during the inspection, the time interval for subsequent inspections may need to be shortened to something less than 10 years, particularly during LTO.	Consider increasing inspection frequency if degradation is observed prior to or during LTO.
4.3: The program description states that "the effectiveness of the program is verified to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation. Thickness measurement of tank bottom surfaces is an acceptable verification program."	The AMP provides no further guidance on acceptable methods for determining the thickness of the fuel oil tank bottom or on acceptance criteria. Two UT inspections of the fuel oil tanks performed at NMP-1 found regions where the local thickness was less than the acceptance criteria, and engineering evaluations were performed to verify the structural integrity of the tank. An industry standard or some other guidance is desirable to address tank bottom thickness determinations and acceptance criteria in more detail.	Consider providing additional guidance on tank bottom thickness measurements and acceptance criteria.
5. Monitoring and Trending		
Water, biological activity, and particulate contamination concentrations are monitored and trended in accordance with the plant's technical specifications or at least quarterly.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
Acceptance criteria for fuel oil quality parameters are as invoked or referenced in a plant's technical specifications. Additional acceptance criteria may be implemented using guidance from industry standards and equipment manufacturer or fuel oil supplier recommendations. ASTM D 0975-04 or other appropriate standards may be used to develop fuel oil quality acceptance criteria. Suspended water concentrations are in accordance with the applicable fuel oil quality specifications. Corrective actions are taken if microbiological activity is		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
detected.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Specific corrective actions are implemented in accordance with the plant quality assurance (QA) program. For example, corrective actions are taken to prevent recurrence when the specified limits for fuel oil standards are exceeded or when water is drained during periodic surveillance. If accumulated water is found in a fuel oil storage tank, it is immediately removed. In addition, when the presence of biological activity is confirmed, a biocide is added to fuel oil. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
The operating experience at some plants has included identification of water in the fuel, particulate contamination, and biological fouling. In addition, when a diesel fuel oil storage tank at one plant was cleaned and visually inspected, the inside of the tank was found to have unacceptable pitting corrosion (>50% of the wall), which was repaired in accordance with American Petroleum Institute (API) 653 standard by welding patch plates over the affected area.		
10.1: No specific concerns for LTO.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

API 653, *Tank Inspection, Repair, Alteration, and Reconstruction*, American Petroleum Institute, April 23, 2009.

ASTM D 0975-04, *Standard Specification for Diesel Fuel Oils*, American Society for Testing Materials, West Conshohocken, PA, 2004.

ASTM D 1796-97,*Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method*, American Society for Testing Materials, West Conshohocken, PA, 1997.

ASTM D 2276-00,*Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling*, American Society for Testing Materials, West Conshohocken, PA, 2000.

ASTM D 2709-96,*Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge*, American Society for Testing Materials, West Conshohocken, PA, 1996.

ASTM D 4057-95, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*, American Society for Testing Materials, West Conshohocken, PA, 2000.

ASTM D 6217-98, *Standard Test Method for Particulate Contamination in Middle Distillate Fuels by Laboratory Filtration*, American Society for Testing Materials, West Conshohocken, PA,1998.

NRC Regulatory Guide 1.137, Rev. 1, *Fuel-Oil Systems for Standby Diesel Generators*, U.S. Nuclear Regulatory Commission, October 1979.

NRC Safety Evaluation Report Related to the License Renewal of Three Mile Island Nuclear Unit 1, Section 3.0.3.2.12, *Fuel Oil Chemistry – Operating Experience*, June 2009.

A.29 XI.M31 Reactor Vessel Surveillance

The verbatim text of GALL, Rev. 2, AMP XI.M31, Reactor Vessel Surveillance, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The Code of Federal Regulations, 10 CFR Part 50, Appendix H, requires that peak neutron fluence at the end of the design life of the vessel will not exceed 1017 n/cm2 (E >1MeV), or that reactor vessel beltline materials be monitored by a surveillance program to meet the American Society for Testing and Materials (ASTM) E 185 Standard. However, the surveillance program in ASTM International Standard Practice E 185-82 is based on plant operation during the current license term, and additional surveillance capsules may be needed for the period of extended operation. Alternatively, an integrated surveillance program for the period of extended operation may be considered for a set of reactors that have similar design and operating features in accordance with 10 CFR Part 50, Appendix H (2009), Paragraph III.C. Additional surveillance capsules may also be needed for the period of extended operation for this alternative. The objective of the reactor vessel material surveillance program is to provide sufficient material data and dosimetry to (a) monitor irradiation embrittlement at the end of the period of extended operation and (b) determine the need for operating restrictions on the inlet temperature, neutron spectrum, and neutron flux. If surveillance capsules are not withdrawn during the period of extended operation, operating restrictions are to be established to ensure that the plant is operated under the conditions to which the surveillance capsules were exposed. The program is a condition monitoring program that measures the increase in Charpy V-notch 30 foot-pound (ft-lb) transition temperature and the drop in the upper shelf energy as a function of neutron fluence and irradiation temperature. The data from this surveillance program are used to monitor neutron irradiation embrittlement and are used in the time-limited aging analyses that are described in Section 4.2 of the Standard Review Plan for License Renewal. All capsules in the reactor vessel that are removed and tested must meet the test procedures and reporting requirements of the 1982 edition of ASTM E 185 (ASTM E 185-82), to the extent practicable, for the configuration of the specimens in the capsule. Any changes to the capsule withdrawal schedule, including spare capsules, must be approved by the Nuclear Regulatory Commission (NRC) prior to implementation. Untested capsules placed in storage must be maintained for possible future insertion.		
a.1: (Ginna plant visit) The Ginna SER Appendix A includes Commitment 38, under which the licensee agreed to: (1) Withdraw surveillance capsule in Spring 2005 and submit a test report of results within 1 year, and (2) withdraw the last surveillance capsule shortly after accumulating fluence equivalent to 80 years of operation. However, by letter	WCAP-17036-NP does not clearly address how the licensee has been keeping track of the implantation schedule for the LR commitments, especially the first item of License Renewal Commitment 38. In fact, WCAP-17036-NP does not provide a specific reference to license renewal Commitment 38, even though the major topic of the WCAP report is the test and	Provide more specific guidance in the SRP and GALL on communicatin

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
dated May 29, 2009 (supplemented Feb. 18, 2010), the licensee submitted WCAP-17036-NP, Rev. 0, "Analysis of Capsule N from the R.E. Ginna Reactor Vessel Radiation Surveillance Program," to the NRC. Note (3) of Table 7-1, in WCAP-17036-NP states that Capsule P should be removed at about 33.9 EFPY (effective full power years) to fulfill the commitment of [28] to remove the capsule shortly after it accumulates a fluence equivalent to 80 years of operation (reference [28] refers to the NRC SER for Ginna license renewal).	analysis results for Capsule N, which is, in turn, directly relates to LR Commitment 38. However, the foregoing results point out a need for SLRGDs to provide more specific guidance for how the applicants/licensees should communicate with the NRC when the license renewal commitments are modified or their implementing schedules are changed.	g changes in LR commitments or implementatio n schedules.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description, the guidance in 10 CFR 50, Appendices G and H; 10 CFR 50.61; ASTM E 185-82; NRC Regulatory Guide 1.99, Rev. 2; and 10 CFR 50, Appendix B. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, and the Ginna Reactor Vessel Surveillance Program (B2.1.28) cites 10 CFR 50, Appendix H; ASTM E 185-73, and 10 CFR 50, Appendix B. The NMP-1 Reactor Vessel Surveillance Program (B2.1.19) cites these same documents, as well as BWRVIP-116.		
b.1: The program basis and supporting documents cited in GALL are subject to revisions and updates, and the guidance cited by the applicant may not reflect these revisions and updates.	Unless the program basis and supporting documents are current and complete, the applicant's AMP for LTO will not represent the best available guidance for aging management.	Verify that the guidance cited in the AMP for LTO is current and complete.
Program Consistency and Commitments		
The Ginna Reactor Vessel Surveillance Program (B2.1.28) claims consistency with GALL, Rev. 0, with no exceptions, enhancements, or commitments. However, during its license renewal audit, the NRC identified an apparent exception to GALL guidance related to the schedule for withdrawing surveillance capsules for testing. After additional clarification, this exception was found to be acceptable. The Ginna Reactor Vessel Surveillance Program (B2.1.28) included no commitments. The NMP-1 Reactor Vessel Surveillance Program (B2.1.19) makes no exceptions to GALL, Rev. 0, but adds enhancements that are claimed to encompass revisions to existing activities that are credited for license renewal to ensure the applicable aging effects are discovered and evaluated. These enhancements and the impacted program elements are as follows: ***Program Description***		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Incorporate the requirements and elements of the integrated surveillance program (ISP), as documented in BWRVIP-116 and approved by NRC, or an NRC-approved plant-specific program, into the Reactor Vessel Surveillance Program, and include a requirement that if Nine Mile Point Nuclear Station (NMPNS) surveillance capsules are tested, the tested specimens will be stored in lieu of optional disposal. When the NRC issues a final safety evaluation report (SER) for BWRVIP-116, NMPNS will address any open items and complete the SER Action Items. Should BWRVIP-1 16 not be approved by the NRC, a plant-specific reactor vessel surveillance program will be submitted to the NRC 2 years prior to commencement of the period of extended operation. ***Program Elements I and 3 (Scope of Program, Parameters Monitored/Inspected)*** Project analyses of upper shelf energy and pressure-temperature limits to 60 years using methods prescribed by Regulatory Guide 1.99, Revision 2, and include the applicable bounds of the data, such as operating temperature and neutron fluence. The NMP-1 LRA committed to completing these enhancements prior to the period of extended operation. During the audit review, NMP-1 also agreed to implement the BWRVIP-116 ISP currently under review by the NRC staff or to submit a plant-specific surveillance program for each NMP-1 unit 2 years before it enters the period of extended operation. The staff also required the following license condition: "Implementation of the most recent staff-approved version of BWRVIPISP as the method to demonstrate compliance with the requirements of 10 CFR 50, Appendix H. Any changes to the BWRVIP ISP capsule withdrawal schedule must be submitted for NRC staff review and approval. Any changes to the BWRVIP ISP capsule withdrawal schedule which affects the time of withdrawal of any surveillance capsules must be incorporated into the licensing basis. If any surveillance capsules are removed without the intent to test them, these capsules must be stored in manner which maintains them in a condition which would support re-insertion into the reactor pressure vessel, if necessary." With these additional commitments and conditions, the NRC staff found the NMP-1 Reactor Vessel Surveillance Program to be acceptable.		
c.1: See item 3.4 below.		
1. Scope of Program		
The program includes all reactor vessel beltline materials as defined by 10 CFR 50, Appendix G, Section II.F. Materials originally monitored within the scope of the licensee's existing 10 CFR Part 50, Appendix H, materials surveillance program will continue to serve as the basis for the reactor vessel surveillance aging management program unless safety considerations for the term of the renewed license would require the monitoring of additional or alternative materials.		
1.1: (Ginna plant visit) Section 4.0 of the program basis document (PBD), Rev. 4, states that the licensee's reactor vessel surveillance program includes the following subprograms: (1) Surveillance capsule insertion, withdrawal and evaluation; (2) fluence and uncertainty calculations; (3)	No revision has been made to the PBD since April 2009.	Verify that the PBD is continually updated in a timely

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
monitoring of effective full-power years; (4) development of pressure-temperature limit curves; and (5) calculation and monitoring of low-temperature overpressure protection (LTOP).		manner.
2. Preventive Actions		
The program is a surveillance program; no preventive actions are identified.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
The program monitors reduction of fracture toughness of reactor vessel beltline materials due to neutron irradiation embrittlement and monitors reactor vessel long term operating conditions (cold leg operating temperature and neutron fluence) that could affect neutron irradiation embrittlement of the reactor vessel. The program uses two parameters to monitor the effects of neutron irradiation: (a) the increase in the Charpy V-notch 30 ft-lb transition temperature and (b) the drop in the Charpy V-notch upper shelf energy. The program uses neutron dosimeters to benchmark neutron fluence calculations. Low melting point elements or eutectic alloys may be used as a check on peak specimen irradiation temperature. Preferably, irradiation temperature will be monitored from cold leg operating temperatures. The Charpy V-notch specimens, neutron dosimeters, and temperature monitors are placed in capsules that are located within the reactor vessel; the capsules are withdrawn periodically to monitor the reduction in fracture toughness due to neutron irradiation.		
3.1: The "parameters monitored/inspected" program element of the GALL report, Rev. 2, AMP XI.M31, recommends the use of neutron dosimeters to benchmark the neutron fluence calculations. RG 1.190 issued in March 2001, provides state-of-the-art calculations and measurement procedures that are acceptable to the NRC staff for determining pressure vessel fluence. However, the GALL report, Rev. 2, does not refer to RG 1.190. The GALL report, Rev. 2, also states that preferentially irradiation temperature will be monitored from cold leg operating temperatures.	By contrast, the licensee's program states that the accumulated neutron fluence is monitored from the irradiated material specimens. The program does not clearly address how the licensee's program benchmarks the neutron fluence calculations using the neutron dosimeters. In addition, the program does not clearly describe how it uses the data of the ongoing neutron dosimeter measurements to validate the previous calculations for fluence projections. Furthermore, the program does not clearly describe how the cold leg temperatures, which may affect the degree of reactor vessel irradiation embrittlement, are collected and analyzed in the reactor vessel surveillance program.	The SLR GALL AMP XI.M31, to include RG 1.190 as a reference and provide guidance for fluence calculation, benchmark, and validation.
3.2: The licensee indicated that when a capsule is removed, the neutron dosimetry data from the withdrawn capsules are	During the audit, the licensee indicated that it has no formal procedure for the projection of the accumulated fluence in the	The SLR GALL should

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
evaluated to validate the fluence calculation. In addition, the PBD indicates that monitoring of EFPY is necessary to enable a projection of the fluence of the reactor vessel belt line material as a function of time. The PBD indicates that pressurized thermal shock (PTS) curves are normally developed based on a particular projection of EFPY, beyond which they are not valid. The PBD also indicates that EFPY calculations are performed at Ginna Station by using the Daily Reactor Power Log.	vessel for out years; however, the engineering staff performs the projections using the power data. Furthermore, the licensee (or the program basis document) did not clearly address how frequently the ongoing dosimetry data are used to validate the flux/fluence calculations and projections especially between the refueling outages when capsules are withdrawn.	include the more-detailed guidance for the validation of fluence calculations and projections.
3.3: As the fluence level is increased, non-belt-line material such as reactor vessel nozzles may become the limiting component. Therefore, there may be a need to expand the definition of limiting materials and analyses to be considered in the identification of the limiting materials (and components). It is also noted that currently the Integrated Reactor Pressure Vessel (RPV) Project is being conducted to address and resolve technical and regulatory items of potential concerns based on the most current understanding on the irradiation embrittlement and integrity of reactor pressure vessels. The outcome of the RPV Project should be considered in the revisions to the Reactor Vessel Surveillance Program.	The license renewal guidance, especially for the subsequent license renewal period, should more clearly address the definition of “limiting material.” As the reactor vessel materials continue to be exposed to neutron irradiation fluence and age, the list of the “limiting” materials should be updated accordingly and relevant testing and analysis should be performed to ensure that, “newly identified” limiting materials/locations are adequately evaluated.	The guidance for determining the “limiting material” may require updating for LTO.
3.4: (Ginna plant visit) Ginna indicated that they are expecting the last capsule (sixth capsule P) to be withdrawn in about 2018 after exposure to the 80-year-operation fluence level projected for the reactor vessel. If Ginna were to continue its operation for the subsequent license renewal period, it would enter the second license renewal period in 2029, which means that if no additional capsule is reinstituted, Ginna would operate for additional 30 years without a capsule in the reactor vessel. In the broader picture, extended operation beyond 60 years increases the likelihood that a number of licensees will exhaust their supply of surveillance capsules in the reactor vessel. This means that they will increasingly be forced to rely on the alternatives given in GALL AMP XI.M31.	Currently, GALL, Rev. 2, recommends that if all surveillance capsules have been removed, a licensee may seek membership in an integrated surveillance program unless the integrated surveillance program does not have surveillance material representative of its limiting beltline materials or the program can propose one of the following: (a) An active surveillance program with reinstituted specimens, or (b) an alternative neutron monitoring program. However, further evaluation may be needed to confirm that one of the foregoing two options is sufficient to provide adequate and necessary information to manage aging. Both options may be necessary in some cases. In addition, GALL, Rev. 2, does not provide detailed guidance for an alternative neutron monitoring program.	Reevaluate GALL options to integrated surveillance program and provide detailed guidance on an alternative neutron monitoring program.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4. Detection of Aging Effects		
Reactor vessel beltline materials will be monitored by a surveillance program in which surveillance capsules are withdrawn from the reactor vessel and tested in accordance with ASTM E 185-82. This ASTM standard describes the methods used to monitor irradiation embrittlement (described in Element 3, above), selection of materials, and the withdrawal schedule for capsules. However, the surveillance program in ASTM E 185 is based on plant operation during the current license term, and additional surveillance capsules may be needed for the period of extended operation. Alternatively, an integrated surveillance program for the period of extended operation may be considered for a set of reactors that have similar design and operating features in accordance with 10 CFR Part 50, Appendix H, Paragraph III.C. Additional surveillance capsules may also be needed for the period of extended operation for this alternative. The plant-specific or integrated surveillance program shall have at least one capsule with a projected neutron fluence equal to or exceeding the 60-year peak reactor vessel wall neutron fluence prior to the end of the period of extended operation. The program withdraws one capsule at an outage in which the capsule receives a neutron fluence of between one and two times the peak reactor vessel wall neutron fluence at the end of the period of extended operation and tests the capsule in accordance with the requirements of ASTM E 185-82. It is recommended that the program retain additional capsules within the reactor vessel to support additional testing if, for example, the data from the required surveillance capsule turn out to be invalid or in preparation for operation beyond 60 years. If the projected neutron fluence for these additional capsules is expected to be excessive if left in the reactor vessel, the program may propose to withdraw and place one or more untested capsules in storage for future reinsertion and/or testing. If a plant has ample capsules remaining for future use, all pulled and tested samples or capsules placed in storage with reactor vessel neutron fluence less than 50% of the projected neutron fluence at the end of the period of extended operation may be discarded. Pulled and tested samples, unless discarded before August 31, 2000, and capsules with a neutron fluence greater than 50% of the projected reactor vessel neutron fluence at the end of the period of extended operation are placed in storage (these specimens and capsules are saved for future reconstitution and reinsertion use) unless the applicant has gained NRC approval to discard the pulled and tested samples or capsules. If an applicant does not have ample capsules remaining for future use, all pulled and tested capsules, unless discarded before August 31, 2000, are placed in storage. (These specimens are saved for future reconstitution use, in case the surveillance program is reestablished.) Plant-specific and fleet operating experience should be considered in determining the withdrawal schedule for all capsules; the withdrawal schedule shall be submitted as part of a license renewal application for NRC review and approval in accordance with 10 CFR Part 50, Appendix H. If all surveillance capsules have been removed, a licensee may seek membership in an integrated surveillance program unless the integrated surveillance program does not have surveillance material representative of its limiting beltline materials or the program can propose one of the following: (a) An Active Surveillance Program with Reinstituted Specimens This program consists of (1) capsules from a		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
surveillance program described above, (2) reconstitution of specimen from tested capsules, (3) capsules made from any available archival materials, or (4) some combination of the three previous options. This program could be a plant-specific program or an integrated surveillance program. (b) An Alternative Neutron Monitoring Program Programs without in-vessel capsules use alternative dosimetry to monitor neutron fluence during the period of extended operation. If all surveillance capsules have been removed, operating restrictions are established to ensure that the plant is operated under conditions to which the surveillance capsules were exposed. The exposure conditions of the reactor vessel are monitored to ensure that they continue to be consistent with those used to project the effects of embrittlement to the end of license. If the reactor vessel exposure conditions (neutron flux, spectrum, irradiation temperature, etc.) are altered, then the basis for the projection to 60 or more years is reviewed and, if deemed appropriate, modifications are made to the Reactor Vessel Surveillance program. Any changes to the Reactor Vessel Surveillance program must be submitted for NRC review and approval in accordance with 10 CFR Part 50, Appendix H.		
4.1: As a part of its reactor vessel surveillance AMP, NMP-1 is participating in an ISP as described in BWRVIP-116. However, the ISP provisions of BWRVIP-116 and BWRVIP-86-A have recently been merged into BWRVIP-86, Rev. 1, which was approved by the NRC in October 2011 and supercedes BWRVIP-116.	During the audit interview, NMP-1 personnel indicated that their ISP is being updated to conform to the new guidance in BWRVIP-86, Rev. 1. The same guidance should be incorporated into updated GALL guidance on an ISP for LTO (XI.M31. Reactor Vessel Surveillance).	Ensure that latest NRC-approved industry guidance is incorporated.
5. Monitoring and Trending		
The program provides reactor vessel material fracture toughness data for the time limited aging analyses (TLAAs) on neutron irradiation embrittlement (e.g., upper-shelf energy, pressurized thermal shock and pressure-temperature limits evaluations, etc.) for 60 years. The program is designed to periodically remove and test capsules for monitoring and trending purposes. Refer to the Standard Review Plan for License Renewal, Section 4.2, for the NRC acceptance criteria and review procedures for reviewing TLAAs for neutron irradiation embrittlement. The TLAAs are projected in accordance with NRC Regulatory Guide (RG) 1.99, Rev. 2, "Radiation Embrittlement of Reactor Vessel Materials," and the pressurized thermal shock rules (10 CFR 50.61 or 10 CFR 50.61a). When using NRC RG 1.99, Rev. 2, or equivalent provisions in 10 CFR 50.61, a licensee has a choice of the following: (a) Neutron Embrittlement Using Chemistry Tables and Upper Shelf Energy Figures. An applicant may use the tables and figures in NRC RG 1.99, Rev. 2, to project the extent of reactor vessel neutron embrittlement for the period of extended operation based on material chemistry and neutron fluence. This is described as Regulatory Position 1 in NRC RG 1.99, Rev. 2. (b) Neutron Embrittlement Using Surveillance Data. When two or more credible surveillance data sets are available, the extent of reactor vessel neutron embrittlement for the period of extended operation may be projected according to Regulatory Position 2 in NRC RG 1.99, Rev. 2, based on best fit of the surveillance data. The credible data could be collected during the current and extended operating		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
term. A plant-specific program or an integrated surveillance program during the period of extended operation provides for the collection of additional data. A program that determines embrittlement by using NRC RG 1.99, Rev. 2, tables and figures (item [a]) uses the applicable limitations in Regulatory Position 1.3 of NRC RG 1.99, Rev. 2. The limits are based on material properties, temperature, material chemistry, and neutron fluence. The program that determines embrittlement by using surveillance data (item [b]) defines the applicable bounds of the data, such as cold leg operating temperature and neutron fluence. These bounds are specific for the referenced surveillance data. For example, the plant-specific data could be collected within a smaller temperature range than that in NRC RG 1.99, Rev. 2. The reactor vessel monitoring program provides that if future plant operations exceed these limitations or bounds, such as operating at a lower cold leg temperature or higher fluence, the impact of plant operation changes on the extent of reactor vessel embrittlement is evaluated and the NRC is notified.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
The data are used for reactor vessel embrittlement projections to comply with 10 CFR Part 50, Appendix G, requirements and 10 CFR 50.61 or 10 CFR 50.61a limits through the period of extended operation.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
There are no acceptance criteria that apply to the surveillance data, but the results of surveillance capsule testing will be incorporated into site operating limitations. The data will be used for reactor vessel embrittlement projections to comply with 10 CFR Part 50, Appendix G, requirements and 10 CFR 50.61 or 10 CFR 50.61a limits through the period of extended operation. If a capsule is not withdrawn as scheduled, the NRC is notified and a revised withdrawal schedule is submitted to the NRC. Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B,		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
acceptable to address the confirmation process, and administrative controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
The existing reactor vessel material surveillance program provides sufficient material data and dosimetry to (a) monitor irradiation embrittlement at the end of the period of extended operation and (b) determine the need for operating restrictions on the inlet temperature, neutron fluence, and neutron flux.		
10.1: No specific concerns for LTO.		

References

10 CFR Part 50, Appendix G, *Fracture Toughness Requirements,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR Part 50, Appendix H, *Reactor Vessel Material Surveillance Program Requirements*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.61, *Fracture Toughness Requirements for Protection against Pressurized Thermal Shock Events*, Office of the Federal Register, National Archives and Records Administration, January 4, 2010.

10 CFR 50.61a, *Alternate Fracture Toughness Requirements for Protection against Pressurized Thermal Shock Events*, Office of the Federal Register, National Archives and Records Administration, January 4, 2010.

ASTM E 185-82, *Standard Practice for Conducting Surveillance Tests of Light-Water Cooled Nuclear Power Reactor Vessels,* American Society for Testing Materials, Philadelphia, PA. (Versions of ASTM E 185 to be used for the various aspects of the reactor vessel surveillance program are as specified in 10 CFR Part 50, Appendix H.)

NRC Regulatory Guide 1.99, Rev. 2, *Radiation Embrittlement of Reactor Vessel Materials*, U.S. Nuclear Regulatory Commission, May 1988.

Additional References

NRC Regulatory Guide 1.190, *Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence*, U.S. Nuclear Regulatory Commission, March 2001.

A.30 XI.M32 One-Time Inspection

The verbatim text of GALL, Rev. 2, AMP XI.M32, One-Time Inspection, is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
A one-time inspection of selected components is used to verify the system-wide effectiveness of an aging management program (AMP) that is designed to prevent or minimize aging to the extent that it will not cause the loss of intended function during the period of extended operation. For example, effective control of water chemistry under the XI.M2, "Water Chemistry," program can prevent some aging effects and minimize others. However, there may be locations that are isolated from the flow stream for extended periods and are susceptible to the gradual accumulation or concentration of agents that promote certain aging effects. This program provides inspections that verify that unacceptable degradation is not occurring. It also may trigger additional actions that ensure the intended functions of affected components are maintained during the period of extended operation. The program verifies the effectiveness of an AMP and confirms the insignificance of an aging effect. Situations in which additional confirmation is appropriate include (a) an aging effect is not expected to occur, but the data are insufficient to rule it out with reasonable confidence; or (b) an aging effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected. For these cases, confirmation demonstrates that either the aging effect is not occurring or that the aging effect is occurring very slowly and does not affect the component's or structure's intended function during the period of extended operation based on prior operating experience data. This program does not address Class 1 piping less than nominal pipe size (NPS) 4. That piping is addressed in AMP XI.M35, "One Time Inspection of ASME Code Class 1 Small Bore-Piping." The elements of the program include (a) determination of the sample size of components to be inspected based on an assessment of materials of fabrication, environment, plausible aging effects, and operating experience; (b) identification of the inspection locations in the system or component based on the potential for the aging effect to occur; (c) determination of the examination technique, including acceptance criteria that would be effective in managing the aging effect for which the component is examined; and (d) evaluation of the need for follow-up examinations to monitor the progression of aging if age-related degradation is found that could jeopardize an intended function before the end of the period of extended operation. An acceptable (one-time inspection) program to verify system-wide effectiveness of an AMP may consist of a one-time inspection of selected components and susceptible locations in the selected system. Verification may include a review of routine maintenance, repair, or inspection records to confirm that selected components have been inspected for aging degradation and that significant aging degradation has not occurred. A one-time inspection program is acceptable to verify the effectiveness of AMP XI.M2, "Water Chemistry"; AMP XI.M30,		

[1] Proposed NRC action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
"Fuel Oil Chemistry"; and AMP XI.M39, "Lubricating Oil Analysis," programs or where the environment in the period of extended operation is expected to be equivalent to that in the prior 40 years and for which no aging effects have been observed. However, one-time inspection for environments that do not fall in the above category, or of any other action or program created to verify the effectiveness of an AMP and confirm the absence of an aging effect, is to be reviewed by the staff on a plant-specific basis. This program cannot be used for structures or components with known age-related degradation mechanisms or when the environment in the period of extended operation is not expected to be equivalent to that in the prior 40 years. Periodic inspections should be proposed in these cases.		
a.1: The One-Time Inspection Program provides an acceptable means to verify the effectiveness of other AMPs where the environment in the PEO is expected to be equivalent to that in the prior 40 years and for which no aging effects have been observed. The program description states that this AMP is applicable to situations where (a) an aging effect is not expected to occur, but the data are insufficient to rule it out with reasonable confidence; or (b) an aging effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected.	These same criteria for the applicability of the One-Time Inspection Program may be applied to operation beyond 60 years. However, in view of the increased service times of the components subject to inspection, the details of the program with respect to sample size and sampling and inspection techniques should be reviewed on a plant-specific basis to ensure that the program is sufficiently rigorous to detect degradation that was not detectable after 40 years but has become significant after an additional 20 years.	Review details of this AMP on a plant-specific basis when applied to LTO.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in 10 CFR 50, Appendix B; 10 CFR 50.55a; ASME Section XI; BWRVIP-03 (EPRI 105696- R6); and MRP-228. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, and the Ginna One-Time Inspection Program (B2.1.21) cites ASME Section XI and 10 CFR 50, Appendix B. The NMP-1 One-Time Inspection Program (B2.1.20) cites EPRI TR-107514 and 10 CFR 50, Appendix B.		
b.1: The program basis and supporting documents cited in GALL are subject to revisions and updates, and the guidance cited by the applicant may not reflect these revisions and updates.	Unless the program basis and supporting documents are current and complete, the applicant's AMP for LTO will not represent the best available guidance for aging management.	Verify that the guidance cited in the AMP for LTO is current and complete.
Program Consistency and Commitments		
Both the Ginna One-Time Inspection Program (B2.1.21) and the NMP-1 One-Time Inspection Program (B2.1.20) claim consistency with		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
GALL, Rev. 0, with no exceptions or enhancements. The Ginna AMP contains no commitments, but the NMP-1 LRA includes a commitment to develop and implement the One-Time Inspection Program prior to the period of extended operation that also includes the attributes for a selective Leaching of Materials Program.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
The scope of this program includes systems and components that are subject to aging management using the GALL AMPs XI.M2, "Water Chemistry"; XI.M30, "Fuel Oil Chemistry"; and XI.M39, "Lubricating Oil Analysis," and for which no aging effects have been observed or for which the aging effect is occurring very slowly and does not affect the component's or structure's intended function during the period of extended operation based on prior operating experience data. The scope of this program also may include other components and materials where the environment in the period of extended operation is expected to be equivalent to that in the prior 40 years and for which no aging effects have been observed. The program cannot be used for structures or components subjected to known age-related degradation mechanisms or when the environment in the period of extended operation is not expected to be equivalent to that in the prior 40 years. Periodic inspections should be proposed in these cases.		
1.1: (Ginna plant visit) During the Ginna audit, an issue was raised about stress corrosion cracking of stainless steel in an environment less than 140°F. The site identified multiple examples for thin-walled piping (schedule 10) that showed sensitization of the heat-affected zone of the weld. During discussions, licensee personnel said a new operating experience document was not considered, since this issue is specifically addressed in NRC IN 2011-04, "Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Steel Piping in Pressurized Water Reactors."	Although this does not specifically impact the One-Time Inspection Program, including an AMR line item to address this issue should be considered.	Revise appropriate GALL table to include AMR line item on sensitization and possible SCC of SS piping at <40°F (NRC IN 2011-04).
1.2: NUREG-1801, Rev. 2, states under XI.M32 Program Element 1 that "the scope of this program includes systems and components that are subject to aging management using the GALL AMPs XI.M2, 'Water Chemistry'; XI.M30, 'Fuel Oil Chemistry'; and XI.M39, 'Lubricating Oil Analysis,' and for which no aging effects have been observed or for which the aging effect is occurring very slowly and does not	SSCs for which aging is managed by the AMPs listed below may also require one-time inspections before extending operations beyond 60 years. The purpose of these inspections would be similar to that stated in the present AMP XI.M32, namely to verify the effectiveness of an AMP and confirm the insignificance of an aging effect. The additional AMPs to which one-time inspections might be applied include XI.M3 ("Reactor Head Closure Stud	Consider revising the relevant program elements to include additional

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
affect the component's or structure's intended function during the period of extended operation based on prior operating experience data." However, for extended operation beyond 60 years, one-time inspections may be required to verify the system-wide effectiveness of other AMPs in addition to XI.M2, XI.M30, and XI.M39. Aging processes determined to be too slow to produce failure during extended plant operation to 60 years may become problematic beyond 60 years, and a one-time inspection can be used to verify the absence of significant degradation for a wide variety of SSCs.	Bolting"), XI.M10 ("Boric Acid Corrosion"), XI.M17 ("Flow-Accelerated Corrosion"), XI.M18 ("Bolting Integrity"), XI.M27 ("Fire Water System"), XI.M33 ("Selective Leaching"), and XI.M41 ("Buried and Underground Piping and Tanks"), among others.	AMPs subject to confirmation by one-time inspection. Expand table under Program Element 4 as necessary to include additional parameters monitored and inspection techniques.
2. Preventive Actions		
One-time inspection is a condition monitoring program. It does not include methods to mitigate or prevent age-related degradation.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
The program monitors parameters directly related to the age-related degradation of a component. Examples of parameters monitored and the related aging effect are provided in the table in Element 4. Inspection is performed using a variety of nondestructive examination (NDE) methods, including visual, volumetric, and surface techniques.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
Elements of the program include (a) determination of the sample size of components to be inspected based on an assessment of materials of fabrication, environment, plausible aging effects, and operating experience; (b) identification of the inspection locations in the system or component based on the potential for the aging effect to occur; and (c) determination of the examination technique, including acceptance criteria that would be effective in managing the aging effect for which the component is examined. Where practical, the inspection includes a representative sample of the system population and focuses on the bounding or lead components most susceptible to aging due to time in service, and severity of operating conditions. For components managed by the AMP XI.M2, Water Chemistry"; AMP XI.M30, "Fuel Oil Chemistry"; and AMP XI.M39, "Lubricating Oil Analysis," programs, a representative sample size is 20% of the population (defined as components having the same material, environment, and aging effect combination) or a maximum of 25 components. Otherwise, a technical justification of the methodology and sample size used for selecting		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
components for one-time inspection should be included as part of the program's documentation. The program relies on established NDE techniques, including visual, ultrasonic, and surface techniques. Inspections are performed by personnel qualified in accordance with site procedures and programs to perform the type of examination specified. For code components, examinations should follow procedures consistent with the American Society of Mechanical Engineers (ASME) Code. The inspection and test techniques shall have a demonstrated history of effectiveness in detecting the aging effect of concern. Typically, the one-time inspections shall be performed as indicated in the table found in GALL, Rev. 2, AMP XI.M32. With respect to inspection timing, the sample of components inspected before the end of the current operating term needs to be sufficient to provide reasonable assurance that the aging effect will not compromise any intended function during the period of extended operation. Specifically, inspections need to be completed early enough to ensure that the aging effects that may affect intended functions early in the period of extended operation are appropriately managed. Conversely, inspections need to be timed to allow the inspected components to attain sufficient age to ensure that the aging effects with long incubation periods (i.e., those that may affect intended functions near the end of the period of extended operation) are identified. Within these constraints, the applicant should schedule the inspection no earlier than 10 years prior to the period of extended operation and in such a way as to minimize the impact on plant operations. As a plant will have operated for at least 30 years before inspections under this program begin, sufficient time will have elapsed for any aging effects to be manifested.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
This is a one-time inspection program. Monitoring and trending are not applicable.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
Any indication or relevant conditions of degradation detected are evaluated. Acceptance criteria may be based on applicable ASME or other appropriate standards, design basis information, or vendor-specified requirements and recommendations. For example, ultrasonic thickness measurements are compared to predetermined limits.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Unacceptable inspection findings are evaluated in accordance with the site's corrective action process to determine appropriate corrective actions and the need for subsequent (including periodic) inspections under another AMP. Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Confirmation processes to ensure that preventive actions are adequate and that appropriate corrective actions have been completed and are effective are implemented through the site QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
Administrative controls to provide a formal review and approval for corrective actions are implemented through the site QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
The elements that comprise inspections associated with this program (the scope of the inspections and inspection techniques) are consistent with industry practice. An applicant's operating experience with detection of aging effects should be adequate to demonstrate that the program is capable of detecting the presence or noting the absence of aging effects in the components, materials, and environments where onetime inspection is used to confirm system-wide effectiveness of another preventive or mitigative AMP.		
10.1: See item 1.1 above.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

BWRVIP-03 (EPRI 105696- R6), *BWR Vessel and Internals Project: Reactor Pressure Vessel and Internals Examination Guidelines*, January 6, 2004, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, June 2008.

MRP-228, Materials Reliability Program: *Inspection Standard for PWR Internals*, 2009.

A.31 XI.M33 Selective Leaching

The verbatim text of GALL, Rev. 2, AMP XI.M33, Selective Leaching, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program demonstrates the absence of selective leaching. The program for selective leaching of materials ensures the integrity of the components made of gray cast iron and copper alloys (except for inhibited brass) that contain greater than 15 percent zinc (> 15% Zn) or greater than 8 percent aluminum (>8% Al in the case of aluminum-bronze) exposed to a raw water, closed cooling water, treated water, or ground water environment that may lead to selective leaching of one of the metal components where there has not been previous experience of selective leaching. The AMP includes a one-time visual inspection of selected components that may be susceptible to selective leaching, coupled with either hardness measurements (where feasible, based on form and configuration) or mechanical examination techniques. These techniques can determine whether loss of materials due to selective leaching is occurring and whether selective leaching will affect the ability of the components to perform their intended function for the period of extended operation. The selective leaching process involves the preferential removal of one of the alloying elements from the material, which leads to the enrichment of the remaining alloying elements. Dezincification (loss of zinc from brass) and graphitization (removal of iron from cast iron) are examples of such a process. Susceptible materials, high temperatures, stagnant-flow conditions, and a corrosive environment, such as acidic solutions for brasses with high zinc content and dissolved oxygen, are conducive to selective leaching. Although the program does not provide guidance on preventive action, it is noted that monitoring of water chemistry to control pH and concentration of corrosive contaminants and treatment to minimize dissolved oxygen in water are effective in reducing selective leaching. Water chemistry is managed by the Water Chemistry program (AMP XI.M2).		
a.1: See item 10.1 below.		
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in EPRI TR-107514 and 10 CFR 50, Appendix B. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0. The Ginna Selective Leaching of Materials Program (B2.1.29) utilizes visual inspections performed under its Periodic Surveillance/Preventive Maintenance Program (Section B2.1.23), or its One-Time Inspection Program (Section B2.1.21), to determine if selective leaching is occurring in susceptible components and does not cite any specific program basis or supporting documents. Likewise, the NMP-1 Selective Leaching Program (B2.1.21) is implemented through its One-Time Inspection Program (B2.1.20) and cites no specific program basis or supporting documents.		
b.1: No specific concerns for LTO.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Consistency and Commitments		
The Ginna Selective Leaching of Materials Program (B2.1.29) claims consistency with GALL, Rev. 0, with the exception that hardness testing will not be performed as part of the program. Instead, the feasibility of performing hardness tests and the value of hardness test data will be assessed on a component-specific basis. After additional clarification, the NRC staff found this exception to be acceptable. The NMP-1 Selective Leaching Program (B2.1.21) claims consistency with GALL, Rev. 0, with no exceptions or enhancements. The Ginna AMP contains no commitments, but the NMP-1 LRA includes a commitment to develop and implement the One-Time Inspection Program prior to the period of extended operation that also includes the attributes for a selective Leaching of Materials Program.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
This program demonstrates the absence of selective leaching. For materials and environments where selective leaching is currently occurring or for materials in environments where the component has been repaired with the same material, a plant-specific program is required. Components include piping, valve bodies and bonnets, pump casings, and heat exchanger components that are susceptible to selective leaching. The materials of construction for these components may include gray cast iron and uninhibited brass containing greater than 15% zinc. These components may be exposed to raw water, treated water, closed cooling water, ground water, water contaminated fuel oil, or water contaminated lube oil.		
1.1: No specific concerns for LTO.		
2. Preventive Actions		
This program is a condition monitoring program and it contains no preventive actions.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
This program monitors selective leaching through the monitoring of surface hardness and visual appearance (color, porosity, abnormal surface conditions).		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
The visual inspection and hardness measurement or other mechanical examination techniques, such as destructive testing (when the opportunity arises), chipping, or scraping, is a one-time inspection conducted within the last 5 years prior to entering the period of extended operation. Because selective leaching is a slow acting corrosion process, this measurement is performed just prior to the period of extended operation. Follow-up of unacceptable inspection findings includes an evaluation using the corrective action program and a		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
possible expansion of the inspection sample size and location. Where practical, the inspection includes a representative sample of the system population and focuses on the bounding or lead components most susceptible to aging due to time in service, severity of operating conditions, and lowest design margin. Twenty percent of the population with a maximum sample of 25 constitutes a representative sample size. Otherwise, a technical justification of the methodology and sample size used for selecting components for one-time inspection should be included as part of the program's documentation. Each group of components with different material/environment combinations is considered a separate population. Selective leaching generally does not cause changes in dimensions and is difficult to detect by visual inspection. However, in certain brasses, it causes plug-type dezincification, which can be detected by visual inspection. One acceptable procedure is to visually inspect the susceptible components closely and conduct Brinell hardness testing (where feasible, based on form and configuration or other industry-accepted mechanical inspection techniques) on the inside surfaces of the selected set of components to determine if selective leaching has occurred. If selective leaching is apparent, an engineering evaluation is initiated to determine acceptability of the affected components for further service.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
This is a one-time inspection to determine if selective leaching is an issue. Monitoring and trending is not required.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
The acceptance criteria are no visible evidence of selective leaching or no more than a 20 percent decrease in hardness. For copper alloys with greater than 15 percent zinc, the criteria is no noticeable change in color from the normal yellow color to the reddish copper color.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Engineering evaluations are performed for test or inspection results that do not satisfy established acceptance criteria. The corrective actions program ensures that conditions adverse to quality are promptly corrected. If the deficiency is assessed to be significantly adverse to quality, the cause of the condition is determined and an action plan is developed to preclude repetition. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions. Unacceptable inspection findings result in additional inspection(s) being performed, which may be on a periodic basis, or in component repair or replacement.		
7.1: No specific concerns for LTO.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
8. Confirmation Process		
Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice and staff expectations. Selective leaching has been detected in components constructed from cast iron, brass, bronze, and aluminum bronze. Components affected have included valve bodies, pump casings, piping, and cast iron fire protection piping buried in soil.		
10.1: Inspections at Ginna positively identified one example of selective leaching in the gray cast iron drain plug of an auxiliary feedwater pump outboard bearing cooler. Evidence of degradation was also found on five other pumps but could not be definitely determined to be a result of selective leaching. Possible selective leaching was also found on Multimatic valves on the underside of the clapper. As a result of these findings and in conformance with GALL XI.M33, a plant-specific program has been developed whereby the components in question are inspected every quarter under the Ginna Preventive Surveillance and Periodic Maintenance Program. If follow-on destructive examinations verify selective leaching in one of the suspect pumps, all six pumps will be replaced with cast steel pumps.	This operating experience at Ginna indicates that their Selective Leaching Program is effective in managing this aging effect and is being applied in conformance with GALL XI.M33. In addition, no examples of selective leaching were detected during the one-time inspections performed at NMP, and operating experience at other plants is generally favorable. No significant modifications or updates appear to be required in order to apply this AMP to LTO.	Consistent with the current GALL AMP, a one-time inspection for selective leaching should be required before entering the period of extended operation.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI TR-107514, *Age Related Degradation Inspection Method and Demonstration*, Electric Power Research Institute, April 1998.

Fontana, M. G., *Corrosion Engineering*, McGraw Hill, p 86-90, 1986.

NUREG-1705, *Safety Evaluation Report Related to the License Renewal of Calvert Cliffs Nuclear Power Plant, Units 1 and 2*, U.S. Nuclear Regulatory Commission, December 1999.

NUREG-1723, *Safety Evaluation Report Related to the License Renewal of Oconee Nuclear Station, Units 1, 2, and 3*, U.S. Nuclear Regulatory Commission, March 2000.

NUREG-1930, *Safety Evaluation Report Related to the License Renewal of Indian Point Nuclear Generating Units 2 and 3*, U.S. Nuclear Regulatory Commission, November 2009.

Schweitzer, P. A., *Encyclopedia of Corrosion Technology* 2nd Ed, Marcel Dekker, p 201-202. March 17, 2004.

A.32 XI.M35 One-Time Inspection of ASME Code Class 1 Small-Bore Piping

The verbatim text of GALL, Rev. 2, AMP XI.M35, One-Time Inspection of ASME Code Class 1 Small-Bore Piping, is included in the following worksheet; all blue text is directly transcribed. The source of information is the result of a general review of the AMP by ANL staff. There was no separate audit report for XI.M35, since the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP. As stated in the "Program Consistency and Commitments" Section below, the Ginna LRA manages the aging of small-bore piping through its One-Time Inspection Program and its Water Chemistry Control Program. Similarly, the NMP-1 LRA manages this aging effect through its One-Time Inspection, Water Chemistry Control, and ASME Section XI ISI Programs.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This program augments the requirements in American Society of Mechanical Engineers (ASME) Code, Section XI, 2004 edition. According to Table IWB-2500-1, Examination Category B-J, Item No. B9.21 and B9.40 of the current ASME Code, an external surface examination of small-bore Class 1 piping should be included for piping less than NPS 4. Other ASME Code provisions exempt from examination piping NPS 1 and smaller. This program is augmented to include piping from NPS 1 to less than NPS 4. Also, Examination Category B-P requires system leakage of all Class 1 piping. However, the staff believes that for a one-time inspection to detect cracking resulting from thermal and mechanical loading or intergranular stress corrosion of full-penetration welds, the inspection should be a volumetric examination. For a one-time inspection to detect cracking in socket welds, the inspection should be either a volumetric or opportunistic destructive examination. (Opportunistic destructive examination is performed when a weld is removed from service for other considerations, such as plant modifications. A sampling basis is used if more than 1 weld is removed.) These examinations provide additional assurance that either aging of small-bore ASME Code Class 1 piping is not occurring or the aging is insignificant, such that a plant-specific aging management program (AMP) is not warranted, and is applicable to small-bore ASME Code Class 1 piping and systems less than 4 inches nominal pipe size (less than NPS 4) and greater than or equal to NPS 1. The program includes pipes, fittings, branch connections, and all full and partial penetration (socket) welds. This program is applicable to systems that have not experienced cracking of ASME Code Class 1 small-bore piping. This program can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking. (Measure of effectiveness includes (1) the one-time inspection sampling is statistically significant;(2) samples will be selected as described in Element 5, Monitoring and Trending below; and (3) no repeated failures over an extended period of time.) For systems that have experienced cracking and operating experience indicates that design changes have not been implemented to effectively mitigate cracking, periodic inspection is proposed, as managed by a plant-specific AMP. Should evidence of cracking be revealed by a one-time inspection, periodic inspection is implemented using a plant-specific AMP. If small bore piping in a particular plant system has experienced cracking, small bore piping in all plant systems are evaluated to determine whether the cause for the cracking affects other systems (corrective action program).		

[1] Proposed NRC action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.1: LRAs prepared under GALL, Rev. 0, guidance do not include a separate AMP for the inspection of Class 1 small-bore piping.	Overall operating experience has shown that the cracking of small-bore piping is a widespread problem, and a separate AMP to manage this form of degradation is needed.	Ensure that a satisfactory AMP for inspection of small-bore piping is in place prior to entering LTO.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in the ASME Code, Section XI; EPRI 1011955; EPRI 1018330; and 10 CFR 50, Appendix B. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, in which the inspection of small-bore piping was included under the One-Time Inspection Program XI.M32. The Ginna LRA manages the aging of small-bore piping through its One-Time Inspection Program (B2.1.21) and its Water Chemistry Control Program (B2.1.37), and the program basis and supporting documents for these programs are given in those program summaries. Similarly, the NMP-1 LRA manages the aging of small-bore piping through its One-Time Inspection (B2.1.20), Water Chemistry Control (B2.1.2), and ASME Section XI Inservice Inspection (B2.1.1 and B2.1.2) Programs.		
b.1: See Item a.1 above.		
Program Consistency and Commitments		
Because neither Ginna nor NMP-1 had separate One-Time Inspection of Small-Bore Piping Programs, program consistency and program commitments do not apply.		
c.1: See Item a.1 above.		
1. Scope of Program		
This program is a one-time inspection of a sample of ASME Code Class 1 piping less than NPS 4 and greater than or equal to NPS 1. This program includes measures to verify that degradation is not occurring, thereby either confirming that there is no need to manage age-related degradation or validating the effectiveness of any existing AMP for the period of extended operation. The one-time inspection program for ASME Code Class 1 small-bore piping includes locations that are susceptible to cracking.		
1.1: No specific concerns for LTO.		
2. Preventive Actions		
This program is a condition monitoring activity independent of methods to mitigate or prevent degradation.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
This inspection detects cracking in ASME Code Class 1 small-bore piping.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
This one-time inspection is designed to provide assurance that aging of ASME Code Class 1 small-bore piping is not occurring, or that the effects of aging are not significant. This inspection does not apply to those plants that have experienced cracking due to stress corrosion, cyclical (including thermal, mechanical, and vibration fatigue) loading, or thermal stratification and thermal turbulence (MRP 146 and MRP 146S). For a one-time inspection to detect cracking in socket welds, the inspection should be either a volumetric or opportunistic destructive examination. (Opportunistic destructive examination is performed when a weld is removed from service for other considerations, such as plant modifications. A sampling basis is used if more than one weld is removed.) For a one-time inspection to detect cracking resulting from thermal and mechanical loading or intergranular stress corrosion of full penetration welds, the inspection should be a volumetric examination. Volumetric examination is performed using demonstrated techniques that are capable of detecting the aging effects in the examination volume of interest. This inspection should be performed at a sufficient number of locations to ensure an adequate sample. This number, or sample size, is based on susceptibility, inspectability, dose considerations, operating experience, and limiting locations of the total population of ASME Code Class 1 small-bore piping locations. If an applicant has never experienced a failure in its ASME Code Class 1 piping (a throughwall crack detected in the subject component by evidence of leakage, or through nondestructive or destructive examination) and has extensive operating history (more than 30 years of operation at time of submitting the application), the inspection sample size should be at least 3% of the weld population or a maximum of 10 welds of each weld type for each operating unit. If the applicant has successfully mitigated any failures in its ASME Class 1 piping, the inspection should include 10% of the weld population or a maximum of 25 welds of each weld type (e.g., full penetration or socket weld) for each operating unit using a methodology to select the most susceptible and risk-significant welds. For socket welds, opportunistic destructive examination can be performed in lieu of volumetric examination. Because more information can be obtained from a destructive examination than from nondestructive examination, the applicant may take credit for each weld destructively examined equivalent to having volumetrically examined two welds. The one time inspection should be completed within the six year period prior to the period of extended operation.		
4.1: GALL, Rev. 2, states in the second sentence of Program Element 4 of AMP XI.M35 that "this inspection does <u>not</u> apply to those plants that have experienced cracking due to stress corrosion, cyclical (including thermal, mechanical, and vibration fatigue) loading, or thermal stratification and thermal turbulence (MRP 146 and MRP 146S)." However, in the second paragraph of the same	This apparent contradiction concerning the applicability of AMP XI.M35 to plants that have experienced cracking needs to be clarified. It appears that the second sentence of Program Element 4 is either incorrect or is worded in such a way as to create confusion.	Revise Program Element 4 to clarify program applicability.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
program element, the AMP states that "If the applicant has successfully mitigated any failures in its ASME Class 1 piping, the inspection should include 10% of the weld population or a maximum of 25 welds of each weld type…" Additionally, in the second sentence of the second paragraph of the Program Description section, the AMP states "This program can also be used for systems that experienced cracking but have implemented design changes to effectively mitigate cracking."		
4.2: Program Element 4 states in the last sentence of the second paragraph that "The one time inspection should be completed within the six year period prior to the period of extended operation."	A second one-time inspection should likewise be performed within the 6-year period prior to the period of extended operation.	Revise Program Element 4 to specify a second one-time inspection prior to LTO.
5. Monitoring and Trending		
This is a one-time inspection to determine whether cracking in ASME Code Class 1 small-bore piping resulting from stress corrosion, cyclical (including thermal, mechanical, and vibration fatigue) loading, or thermal stratification and thermal turbulence (MRP 146 and MRP 146S) is an issue. Evaluation of the inspection results may indicate the need for additional or periodic examinations (i.e., a plant-specific AMP for Class 1 small-bore piping using volumetric inspection methods consistent with ASME Code, Section XI, Subsection IWB).		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
If flaws or indications exceed the acceptance criteria of ASME Code, Section XI, Paragraph IWB-3400, they are evaluated in accordance with ASME Code, Section XI, Paragraph IWB-3131; additional examinations are performed in accordance with ASME Code, Section XI, Paragraph IWB-2430. Evaluation of flaws identified during a volumetric examination of socket welds should be in accordance with IWB-3600.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The site corrective action program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls. Should evidence of cracking be revealed by a one-time inspection, periodic inspection is implemented, as managed by a plant-specific AMP?		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
This inspection uses volumetric inspection techniques with demonstrated capability and a proven industry record to detect cracking in piping weld and base material.		
10.1: NUREG/CR-6923 notes that, for piping in a number of systems, the fatigue failure of socket welds is a high susceptibility item. This assessment is borne out by the operating experience at several plants (e.g., Columbia). Though operating experience is mentioned in the Program Description section of this AMP and in Program Element 4, Program Element 10 ("Operating Experience") mentions only experience with volumetric inspection techniques and makes no reference to plant-specific operating experience concerning cracking in small-bore piping.	Program Element 10 should be expanded to include reference to plant operating experience with cracking in small-bore piping and its relevance to the applicability of this AMP.	Consider revising Program Element 10 to include plant operating experience with cracking in small-bore piping.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

EPRI 1011955, *Materials Reliability Program*: *Management of Thermal Fatigue in Normally Stagnant Non-Isolable Reactor Coolant System Branch Lines* (MRP-146), June 8, 2005.

EPRI 1018330, *Materials Reliability Program: Management of Thermal Fatigue in Normally Stagnant Non-Isolable Reactor Coolant System Branch Lines – Supplemental Guidance* (MRP-146S), December 31, 2008.

NRC Information Notice 97-46, *Unisolable Crack in High-Pressure Injection Piping*, U.S. Nuclear Regulatory Commission, July 9, 1997.

A.33 XI.M36 External Surfaces Monitoring of Mechanical Components

The verbatim text of GALL, Rev. 2, AMP XI.M36, External Surfaces Monitoring of Mechanical Components, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The External Surfaces Monitoring of Mechanical Components program is based on system inspections and walkdowns. This program consists of periodic visual inspections of metallic and polymeric components, such as piping, piping components, ducting, polymeric components, and other components within the scope of license renewal and subject to aging management review (AMR) in order to manage aging effects. The program manages aging effects through visual inspection of external surfaces for evidence of loss of material, cracking, and change in material properties. When appropriate for the component and material, manipulation may be used to augment visual inspection to confirm the absence of elastomer hardening and loss of strength. Loss of material due to boric acid corrosion is managed by the Boric Acid Corrosion program (AMP XI.M10).		
a.1: (Ginna and NMP-1 plant visits) The second paragraph of the program description for the parallel AMP XI.M38 ("Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components") states that "This program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in loss of intended function. If operating experience indicates that there have been repetitive failures caused by loss of material, a plant-specific program will be required. Following a failure, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest."	Loss of material at the external surfaces of piping and ducts, addressed by the present AMP, can also potentially result in loss of intended function. If such failures occur on a repetitive basis, similar limitations on the applicability of this AMP appear to be desirable, particularly for operating periods beyond 60 years.	Revise program description wording.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description, the guidance in 10 CFR 50, Appendix B, and 10 CFR 50.65. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was their System Monitoring Program (B2.1.33),		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
which cites the same 10 CFR guidance listed above. The plant-specific AMP applied at NMP-1 was their Systems Walkdown Program (B2.1.33), which cites 10 CFR 50, Appendix B.		
b.1: No specific concerns for LTO.		
Program Consistency and Commitments		
The Ginna Systems Monitoring Program (B2.1.33) does not state any exceptions or enhancements to GALL, Rev. 0, nor are any commitments identified. The NMP-1 Systems Walkdown Program (B2.1.33) takes no exceptions to GALL, Rev. 0, but states that enhancements to the program encompass revisions to existing activities that are credited for license renewal to ensure the applicable aging effects are discovered and evaluated. The following commitment (no. 30 on p. A1-41 of the amended NMP-1 LRA) is stated: "Enhance the System Walkdown Program to (1) Train all personnel performing inspections in the Systems Walkdown Program to ensure that age related degradation is properly identified and incorporate this training into the site training program; and (2) Specify acceptance criteria for visual inspections to ensure aging related degradation is properly identified and corrected." This commitment is to be met prior to entering the PEO. During the license renewal process, the NRC staff requested several clarifications related to the systems and structures to which the NMP-1 Systems Walkdown program was applicable: The managed aging effects, the detection of aging effects, and the acceptance criteria. After receiving satisfactory responses to these requests, the staff found this AMP to be acceptable.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
This program visually inspects the external surface of in-scope mechanical components and monitors external surfaces of metallic components in systems within the scope of license renewal and subject to AMR for loss of material and leakage. Cracking of stainless steel components exposed to an air environment containing halides may also be managed. This program also visually inspects and monitors the external surfaces of polymeric components in mechanical systems within the scope of license renewal and subject to AMR for changes in material properties (such as hardening and loss of strength), cracking, and loss of material due to wear. This program manages the effects of aging of polymer materials in all environments to which these materials are exposed. The program may also be credited with managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for situations in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program should describe the component internal environment and the credited similar external component environment inspected.		
1.1: (Ginna and NMP-1 plant visits) The license renewal process for a number of plants was completed while GALL, Rev. 0, was in effect, and this edition of GALL does not	The plant-specific programs developed under GALL, Rev. 0, do not necessarily conform to the scope and guidance contained in GALL, Rev. 2. These plant-specific programs	Review plant-specific AMPs and

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
contain AMP XI.M36 but instead calls for a plant-specific program to manage the aging effects now covered in XI.M36.	should be reviewed and updated as necessary prior to LTO to conform to current GALL AMP XI.M36 guidance.	revise as necessary to conform to current GALL AMP XI.M36 guidance prior to LTO.
1.2: The second paragraph of Program Element 1 states that "The program may also be credited with managing loss of material from internal surfaces of metallic components and with loss of material, cracking, and change in material properties from the internal surfaces of polymers, for situations in which material and environment combinations are the same for internal and external surfaces such that external surface condition is representative of internal surface condition. When credited, the program should describe the component internal environment and the credited similar external component environment inspected." The management of loss of material at internal surfaces is also mentioned in Program Element 4 of AMP XI.M36.	The parallel AMP XI.M38 ("Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components") already exists for the management of loss of material from internal surfaces. This wording in AMP XI.M36 appears to create possible ambiguity as to which of these two AMPs is to be applied to managing aging degradation at internal surfaces.	Revise wording of Program Elements 1 and 4 to clarify program applicability with respect to internal surfaces.
2. Preventive Actions		
The External Surfaces Monitoring of Mechanical Components program is a condition monitoring program that does not include preventive actions.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
The External Surfaces Monitoring of Mechanical Components program utilizes periodic plant system inspections and walkdowns to monitor for material degradation and leakage. This program inspects components such as piping, piping components, ducting, polymeric components, and other components. For metallic components, coatings deterioration is an indicator of possible underlying degradation. The aging effects for flexible polymeric components may be monitored through a combination of visual inspection and manual or physical manipulation of the material. "Manual or physical manipulation of the material" means touching, pressing on, flexing, bending, or otherwise manually interacting with the material. The purpose of the manual manipulation is to reveal changes in material properties, such as hardness, and to make the visual examination process more effective in		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
identifying aging effects such as cracking. Examples of inspection parameters for metallic components include: • corrosion and material wastage (loss of material) • leakage from or onto external surfaces (loss of material) • worn, flaking, or oxide-coated surfaces (loss of material) • corrosion stains on thermal insulation (loss of material) • protective coating degradation (cracking, flaking, and blistering) • leakage for detection of cracks on the external surfaces of stainless steel components exposed to an air environment containing halides Examples of inspection parameters for polymers include: • surface cracking, crazing, scuffing, and dimensional change (e.g., “ballooning” and “necking”) • discoloration • exposure of internal reinforcement for reinforced elastomers • hardening as evidenced by a loss of suppleness during manipulation where the component and material are appropriate to manipulation.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
This program manages aging effects of loss of material, cracking, and change in material properties using visual inspection. For coated surfaces, confirmation of the integrity of the paint or coating is an effective method for managing the effects of corrosion on the metallic surface. When required by the ASME Code, inspections are conducted in accordance with the applicable code requirements. In the absence of applicable code requirements, plant specific visual inspections are performed of metallic and polymeric component surfaces using plant-specific procedures implemented by inspectors qualified through plant-specific programs. The inspections are capable of detecting age-related degradation and are performed at a frequency not to exceed one refueling cycle. This frequency accommodates inspections of components that may be in locations that are normally only accessible during outages or access is physically restricted (underground). Surfaces that are not readily visible during plant operations and refueling outages are inspected when they are made accessible and at such intervals that would ensure the components’ intended functions are maintained. The inspections of underground components shall be conducted during each 10-year period beginning 10 years prior to entering the period of extended operation. These normally underground components should be clearly identified in the program scope and inspection intervals provided. Surfaces that are insulated may be inspected when the external surface is exposed (i.e., during maintenance) at such intervals that would ensure that the components’ intended functions are maintained. The intervals of inspections may be adjusted, as necessary, based on plant-specific inspection results and industry operating experience. Visual inspection will identify indirect indicators of flexible polymer hardening and loss of strength and include the presence of surface cracking, crazing,		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
discoloration, and, for elastomers with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Visual inspection should be 100% of accessible components. Visual inspection will identify direct indicators of loss of material due to wear to include dimensional change, scuffing, and for flexible polymeric materials with internal reinforcement, the exposure of reinforcing fibers, mesh, or underlying metal. Manual or physical manipulation can be used to augment visual inspection to confirm the absence of hardening and loss of strength for flexible polymeric materials (e.g., HVAC flexible connectors) where appropriate. The sample size for manipulation should be at least 10 percent of available surface area. Hardening and loss of strength and loss of material due to wear for flexible polymeric materials are expected to be detectable prior to any loss of intended function. This program is credited with managing the following aging effects. • loss of material and cracking for external surfaces • loss of material for internal surfaces exposed to the same environment as the external surface • cracking and change in material properties (hardening and loss of strength) of flexible polymers		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
Visual inspection and manual or physical manipulation activities are performed and associated personnel are qualified in accordance with site controlled procedures and processes. The External Surfaces Monitoring of Mechanical Components program uses standardized monitoring and trending activities to track degradation. Deficiencies are documented using approved processes and procedures, such that results can be trended. However, the program does not include formal trending. Inspections are performed at frequencies identified in Element 4, Detection of Aging Effects.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
For each component/aging effect combination, the acceptance criteria are defined to ensure that the need for corrective actions will be identified before loss of intended functions. For metallic surfaces, any indications of relevant degradation detected are evaluated. For stainless steel surfaces, a clean, shiny surface is expected. The appearance of discoloration may indicate the loss of material on the stainless steel surface. For aluminum and copper alloys exposed to marine or industrial environments, any indications of relevant degradation that could impact their intended function are evaluated. For flexible polymers, a uniform surface texture and uniform color with no unanticipated dimensional change is expected. Any abnormal surface condition may be an indication of an aging effect for metals and for polymers. For flexible materials, changes in physical properties (e.g., the hardness, flexibility, physical dimensions, and color of the material are unchanged from when the material was new) should be evaluated for continued service in the corrective action program. Cracks should be absent within the material. For rigid polymers, surface changes affecting performance, such as erosion, cracking, crazing, checking, and chalking, are subject to further investigation. Acceptance criteria include design standards, procedural requirements, current licensing basis, industry codes or standards, and engineering evaluation.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
External surface inspections through system inspections and walkdowns have been in effect at many utilities since the mid-1990s in support of the Maintenance Rule (10 CFR 50.65) and have proven effective in maintaining the material condition of plant systems. The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice.		
10.1: No specific concerns for LTO.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI 1007933, *Aging Assessment Field Guide*, December 2003.

EPRI 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004.

INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.

A.34 XI.M37 Flux Thimble Tube Inspection

The verbatim text of GALL, Rev. 2, AMP XI.M37, Flux Thimble Tube Inspection, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The Flux Thimble Tube Inspection is a condition monitoring program used to inspect for thinning of the flux thimble tube wall, which provides a path for the incore neutron flux monitoring system detectors and forms part of the reactor coolant system (RCS) pressure boundary. Flux thimble tubes are subject to loss of material at certain locations in the reactor vessel where flow-induced fretting causes wear at discontinuities in the path from the reactor vessel instrument nozzle to the fuel assembly instrument guide tube. A nondestructive examination methodology, such as eddy current testing (ECT) or other applicant-justified and U.S. Nuclear Regulatory Commission (NRC)-accepted inspection method, is used to monitor for wear of the flux thimble tubes. This program implements the recommendations of NRC IE Bulletin 88-09, as described below.		
a.1: The program does not address cracking or cracking with volumetric (wall thinning) wear. The monitoring is only for the detectable wall loss. An important attribute of this wall loss is that it is highly plant specific and location dependent.	All forms of degradation or combined degradations including wear caused by the flow-induced vibrations can lead to leaks of this RCS boundary with potential for non-isolable leak and/or a multiple-failures scenario.	Add clarification.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP uses NRC IE Bulletin 88-09 as its sole basis document for this section.		
b.1: No further review item was identified.		
Program Consistency and Commitments		
Many of the plant-specific programs/attributes or implementations of this GALL AMP have resulted in various commitments over the years. Ginna AMP is plant-specific with Commitment (#39) to include inspections for SCC and wear during each outage since SCC/IGA were previously detected in certain regions of thimble tube; the LRA noted that entire length of each thimble tube will be inspected for SCC by		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
eddy current examination.		
c.1: The program's adequacy in managing the combined SCC (or cracking) and wear degradations within the established criteria for inspection interval may need further evaluation.	Either confirmation of the absence of cracking, or further evaluation may be relevant in consistency review.	Note.
1. Scope of Program		
The flux thimble tube inspection encompasses all of the flux thimble tubes that form part of the RCS pressure boundary. The instrument guide tubes are not in the scope of this program. Within scope are the licensee responses to IE Bulletin 88-09, as accepted by the staff in its closure letters on the bulletin, and any amendments to the licensee responses as approved by the staff.		
1.1: No further review item was identified.		
2. Preventive Actions		
The program consists of inspection and evaluation and provides no guidance on preventive actions.		
2.1: Considerable uncertainty is associated with the results of inspection and evaluation activities, so the program's sole reliance on these is a concern, given the possibility of practical alternatives that may provide some measure of preventive action.	Flushing of the annulus between the thimble tube and guide tube has been in use to reduce likelihood of SCC. A double-wall design of the thimble tube has been proposed/used to increase safety margins against possible leakage. Replacement with alternate wear-resistant material has been considered.	Review.
3. Parameters Monitored/Inspected		
Flux thimble tube wall thickness is monitored to detect loss of material from the flux thimble tubes during the period of extended operation.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
An inspection methodology (such as ECT) that has been demonstrated to be capable of adequately detecting wear of the flux thimble tubes is used to detect loss of material during the period of extended operation. Justification for methods other than ECT should be provided unless use of the alternative method has been previously accepted by the NRC. Examination frequency is based upon actual plant-specific wear data and wear predictions that have been technically justified as providing conservative estimates of flux thimble tube wear. The interval between inspections is established such that no flux thimble tube is		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
predicted to incur wear that exceeds the established acceptance criteria before the next inspection. The examination frequency may be adjusted based on plant-specific wear projections. Re-baselining of the examination frequency should be justified using plant-specific wear-rate data unless prior plant-specific NRC acceptance for the re-baselining is received outside the license renewal process. If design changes are made to use more wear-resistant thimble tube materials (e.g., chrome-plated stainless steel), sufficient inspections are conducted at an adequate inspection frequency, as described above, for the new materials.		
4.1: The identification and interpretation of detected degradation are subject to assumptions regarding wear-scar geometries. The inspection interval (frequency) is dependent on attributes in addition to the adequate detection aspect of the inspection.	The examination frequency is likely to be affected by the wear-scar geometries, which should be conservatively assessed with verification.	Add note to the basis for examination frequency. Review whether parts of this element belong in "Monitoring & Trending."
4.2: The potential for the development of cracking with wearing cannot be ruled out. Cracking is the most likely mode of degradation, as opposed to tube collapse due to thinning, in several cases where leakage and its progression have been noted. The development of cracking can be due to fatigue or related to stress corrosion.	Some limited analysis of NDE data to confirm that only (volumetric) wear is occurring would support the AMP basis. This AMP, to ensure the functionality and pressure boundary of this component, relies on the assumption that wear is the only active degradation.	Add suggestion.
4.3: With regard to thimble tube degradation that is detected, NRC IE Bulletin 88-09 notes that the reporting requirements of 10 CFR 50.72 and 10 CFR 50.73 are applicable.	Require reporting for further actions or confirmation.	Informational.
5. Monitoring and Trending		
Flux thimble tube wall thickness measurements are trended and wear rates are calculated based on plant-specific data. Wall thickness is projected using plant-specific data and a methodology that includes sufficient conservatism to ensure that wall thickness acceptance criteria continue to be met during plant operation between scheduled inspections.		
5.1: Some plant-specific implementations seem to apply	Relatively large underestimation of data-based, as-found	Clarify that

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
conservatism on an average wear rate, either over number of inspection intervals or over the thimble population, or not account for discrepancies in projected and measured wear rates at all. The trending should explicitly account for any non-conservative discrepancies in the location-specific wear rate relevant for the inspection interval.	wear rate, at least on a location-specific basis, if not corrected in the projection methodology for next inspection interval, has the potential to exceed the acceptance limit during service, especially when the remaining margin is not large enough relative to the inherent uncertainty.	the projection method should estimate and use a conservative wear rate.
5.2: Observed wear depths and rates will need to be compared to those projected by the plant-specific approach to judge the adequacy and assurance of the program to manage long-term integrity over the PEO.	Wear rates should be calculated that have been technically justified as conservative estimates. Confirmation of conservatism, especially for this condition-monitoring program, should be an integral part of this program element for it to be effective as intended for the PEO.	Add confirmation aspect to the element description.
5.3: Changes in hardware and/or operating conditions leading to locally increased flow rates, or other related sources likely to adversely impact the wear rate or its trend, need to be addressed.	Extended power uprate (EPU) is an example of an operating condition change that could increase the wear rate.	Add accounting for such factors.
6. Acceptance Criteria		
Appropriate acceptance criteria, such as percent through-wall wear, are established, and inspection results are evaluated and compared with the acceptance criteria. The acceptance criteria are technically justified to provide an adequate margin of safety to ensure that the integrity of the reactor coolant system pressure boundary is maintained. The acceptance criteria include allowances for factors such as instrument uncertainty, uncertainties in wear scar geometry, and other potential inaccuracies, as applicable, to the inspection methodology chosen for use in the program. Acceptance criteria different from those previously documented in the applicant's response to IE Bulletin 88-09 and amendments thereto, as accepted by the NRC, should be justified.		
6.1: There is no single or uniformly applicable (technically justified) acceptance criteria (basis) document formally reviewed and approved by the staff. In addition, any uncertainty in a validated criterion itself should be specified for that criterion. This should not be commingled with other sources of uncertainty that are independent of the acceptance criteria; any improvements or changes in the other sources of uncertainty, which may be plant specific, may become confounded and/or not	Acceptance criteria are specific to both the type of degradation (and its aging effect) and the presumed mode of (final) failure (whether it is tube collapse, or brittle fracture, or buckling, etc.). These should be clearly specified and limited as stated. Acceptable and technically justified uncertainty in the criteria should be specified and treated independently of other sources of uncertainty, in addition to the requirement for an adequate margin of safety.	Revise the element description and recommend review for validated criteria basis.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
properly accounted for.		
7. Corrective Actions		
Flux thimble tubes with wall thickness that do not meet the established acceptance criteria are isolated, capped, plugged, withdrawn, replaced, or otherwise removed from service in a manner that ensures the integrity of the reactor coolant system pressure boundary is maintained. Analyses may allow repositioning of flux thimble tubes that are approaching the acceptance criteria limit. Repositioning of a tube exposes a different portion of the tube to the discontinuity that is causing the wear. Flux thimble tubes that cannot be inspected over the tube length, that are subject to wear due to restriction or other defects, and that cannot be shown by analysis to be satisfactory for continued service are removed from service to ensure the integrity of the reactor coolant system pressure boundary. The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the confirmation process.		
8.1: Items later determined to be inconsistent with the technical information originally submitted in the LRA or in response to requests for additional information (RAIs) need to be evaluated and communicated to the staff.	Guidance needs to be provided because it is closely related to the quality control of the license renewal implementation and commitment change process. This is also related to Part 50.59 requirements.	Add guidance on how to assess/communicate items found to be inconsistent with submittals.
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
In IE Bulletin 88-09 the NRC requested that licensees implement a flux thimble tube inspection program due to several instances of leaks and due to licensees identifying wear. Utilities established inspection programs in accordance with IE Bulletin 88-09, which have shown excellent results in identifying and managing wear of flux thimble tubes. As discussed in IE Bulletin 88-09, the amount of vibration the thimble tubes experience is determined by many plant-specific factors. Therefore, the only effective method for determining thimble tube integrity is through inspections, which are adjusted to account for plant-specific wear patterns and history.		
10.1: Multiple repositionings, discounting of locally high wear rate, not fully accounting for all sources of uncertainty in the wear projections, and not confirming wear (general wall loss) to be the only active degradation (to the exclusion of any cracking) are some of the issues identified in related OE exceptions (some even after two decades of existing programs).	The industry-wide experience in recent years, as referenced in the SERs for the Farley and Diablo Canyon LRAs, has demonstrated the need to limit the tube repositioning actions and to better evaluate the inspection data in confirming the assumed conservatism in the wear projections. Limited inspections to confirm that cracking is not also present would be suggested.	Add summary and root causes of actual OE events and leakages.
10.2: SCC/intergranular attack (IGA) has been noted in the past few instances. In one case this was attributed mainly to lack of flushing of the guide tubes to thimble tube annulus. In addition, several instances of thimble tube leakage and cracking have been noted, some within the first period after inspection, which have not been well characterized or fully reviewed for examining the applicability or effectiveness of this AMP for future avoidance.	If the plant-specific operating experience, or its generic nature, indicates the applicability of cracking (SCC, fatigue, etc.), the AMP should include inspections to detect and manage the cracking and resulting leakage failure of the thimble tubes. Note that this is also one of the highly irradiated components.	Perform a comprehensive review of all related OE to confirm AMP adequacy or revision.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Inspection and Enforcement Bulletin 88-09, *Thimble Tube Thinning in Westinghouse Reactors*, July 26, 1988.

NRC Information Notice No. 87-44, *Thimble Tube Thinning in Westinghouse Reactors*, September 16, 1987.

NRC Information Notice No. 87-44, Supplement 1, *Thimble Tube Thinning in Westinghouse Reactors*, March 28, 1988.

A.35 XI.M38 Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components

The verbatim text of GALL, Rev. 2, AMP XI. XI.M38, Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components, is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff; there was no separate audit report for XI.M38. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was the "Periodic Surveillance and Preventive Maintenance" AMP B2.1.23, and at NMP-1 was the "Preventive Maintenance Program" AMP B2.1.32

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The program consists of inspections of the internal surfaces of metallic piping, piping components, ducting, polymeric components, and other components that are exposed to uncontrolled, air outdoor, condensation, and any water system other than open-cycle cooling water system (XI.M20), closed treated water system (XI.M21A), and fire water system (XI.M27). These internal inspections are performed during the periodic system and component surveillances or during the performance of maintenance activities when the surfaces are made accessible for visual inspection. The program includes visual inspections to ensure that existing environmental conditions are not causing material degradation that could result in a loss of component intended functions. For certain materials, such as polymers, physical manipulation or pressurization (e.g., hydrotesting) to detect hardening or loss of strength should be used to augment the visual examinations conducted under this program. If visual inspection of internal surfaces is not possible, then the applicant needs to provide a plant-specific program. This program is not intended for use on piping and ducts where repetitive failures have occurred from loss of material that resulted in loss of intended function. If operating experience indicates that there have been repetitive failures caused by loss of material, a plant-specific program will be required. Following a failure, this program may be used if the failed material is replaced by one that is more corrosion-resistant in the environment of interest.		
a.1: No specific concerns for LTO.		
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in 10 CFR 50, Appendix B. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP but instead called for a plant-specific program. The plant-specific AMP applied at Ginna was their Periodic Surveillance and Preventive Maintenance Program		

[1] Proposed NRC action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
(B2.1.23), which cites the same 10 CFR guidance listed above. The plant-specific AMP applied at NMP-1 was their Preventive Maintenance Program (B2.1.32), which also cites 10 CFR 50, Appendix B.		
b.1: No specific concerns for LTO.		
Program Consistency and Commitments		
The Ginna Periodic Surveillance and Preventive Maintenance Program (B2.1.23) lists no exceptions to GALL, but it states under Program Elements 3 (“Parameters Monitored/Inspected”), 4 (“Detection of Aging Effects”), and 6 (“Acceptance Criteria’) that “Operations, maintenance, and surveillance test procedures and task descriptions will be enhanced to provide explicit guidance on detection of applicable aging effects and assessment of degradation.” The NMP-1 Preventive Maintenance Program (B2.1.32) makes no exceptions to GALL, Rev. 0, but states that enhancements to the program encompass revisions to existing activities that are credited for license renewal to ensure the applicable aging effects are discovered and evaluated. The following commitment (no. 29 on p. A1-41 of the amended NMP-1 LRA) is stated: “Enhance the Preventive Maintenance Program to (1) Expand the PM Program to encompass activities for certain additional components, identified as requiring Aging Management. Explicitly define the aging management attributes, including the systems and the component types/commodities included in the program; (2) specifically list those activities credited for aging management; (3) specifically list parameters monitored (4) specifically list the aging effects detected; (5) establish a requirement that inspection data be monitored and trended; and (6) establish detailed parameter-specific acceptance criteria.” This commitment is to be met prior to entering the period of extended operation. During the license renewal process, NMP-1 committed to making enhancements to the Preventive Maintenance Program to revise existing procedures. These enhancements would provide the level of detail and specificity needed for staff review of the Preventive Maintenance Program. They would affect the main program elements including "scope of program," "preventive actions," "parameters monitored," "detection of aging effects," "monitoring and trending," and "acceptance criteria." At the request of the NRC staff, these enhancements were to be completed on a schedule of sufficient time for staff review and approval prior to the period of extended operation.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
For metallic components, the program calls for the visual inspection of the internal surface of in-scope components that are not included in other aging management programs for loss of material. For metallic components with polymeric liners or for polymeric and elastomeric components, the program includes visual inspections of the internal polymer surfaces when coupled with additional augmented techniques, such as manipulation or pressurization. This program also includes metallic piping with or without polymeric linings, piping elements, ducting, and components in an internal environment. The program also calls for visual inspection and monitors the internal surfaces of polymeric and elastomeric components in mechanical systems for hardening and loss of strength, cracking, and for loss of material due to wear. The program manages the effects of aging of polymer materials in all environments to which these materials are exposed. Inspections are performed when the internal surfaces are accessible during the performance of periodic surveillances or during		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
maintenance activities or scheduled outages. This program is not intended for piping and ducts where failures have occurred from loss of material from corrosion.		
1.1: The license renewal process for a number of plants was completed while GALL, Rev. 0, was in effect; this edition of GALL does not contain AMP XI.M38 but rather calls for a plant-specific program to manage the aging effects now covered in XI.M38.	The plant-specific programs developed under GALL, Rev. 0, do not necessarily conform to the scope and guidance contained in GALL, Rev. 2. These plant-specific programs should be reviewed and updated as necessary prior to LTO to conform to current GALL AMP XI.M38 guidance.	Review plant-specific AMPs and revise as necessary to conform to current GALL AMP guidance prior to LTO.
2. Preventive Actions		
This program is a condition monitoring program to detect signs of degradation and does not provide guidance for prevention.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
Parameters monitored or inspected include visible evidence of loss of material in metallic components. This program manages loss of material and possible changes in material properties. This program monitors for evidence of surface discontinuities. For changes in material properties, the visual examinations are supplemented, so changes in the properties are readily observable. Examples of inspection parameters for metallic components include the following: • corrosion and material parameters wastage (loss of material) • leakage from or onto internal surfaces (loss of material) • worn, flaking, or oxide-coated surfaces (loss of material) Examples of inspection parameters for polymers are as follows: • surface cracking, crazing, scuffing, and dimensional change (e.g., “ballooning” and “necking”) • discoloration • exposure of internal reinforcement for reinforced elastomers • hardening as evidenced by a loss of suppleness during manipulation where the component and material are appropriate to manipulation		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
Visual and mechanical inspections conducted under this program are opportunistic in nature; they are conducted whenever piping or ducting are opened for any reason. Visual inspections should include all accessible surfaces. Unless otherwise required (e.g., by the ASME code) all inspections should be carried out using plant-specific procedures by inspectors qualified through plant specific programs. The inspection procedures utilized must be capable of detecting the aging effect(s) under consideration. These inspections provide for the detection of aging effects prior to the loss of component function. Visual inspection of flexible polymeric components is performed whenever the component surface is accessible. Visual inspection can provide indirect indicators of the presence of surface cracking, crazing, and discoloration. For elastomers with internal reinforcement, visual inspection can detect the exposure of reinforcing fibers, mesh, or underlying metal. Visual and tactile inspections are performed when the internal surfaces become accessible during the performance of periodic surveillances or during maintenance activities or scheduled outages. Visual inspection provides direct indicators of loss of material due to wear, including dimensional change, scuffing, and the exposure of reinforcing fibers, mesh, or underlying metal for flexible polymeric materials with internal reinforcement. Manual or physical manipulation of flexible polymeric components is used to augment visual inspection, where appropriate, to assess loss of material or strength. The sample size for manipulation is at least 10 percent of available surface area, including visually identified suspect areas. For flexible polymeric materials, hardening, loss of strength, or loss of material due to wear is expected to be detectable prior to any loss of intended function.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
The Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program uses standardized monitoring and trending activities to track degradation. Deficiencies are documented using approved processes and procedures such that results can be trended. However, the program does not include formal trending. Inspections are performed at frequencies identified in Element 4, Detection of Aging Effects.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
For each component/aging effect combination, the acceptance criteria are defined to ensure that the need for corrective actions is identified before loss of intended functions. For metallic surfaces, any indications of relevant degradation detected are evaluated. For stainless steel surfaces, a clean, shiny surface is expected. Discoloration may indicate the loss of material on the stainless steel surface. Any abnormal surface condition may be an indication of an aging effect for metals. For flexible polymers, a uniform surface texture and uniform color with no unanticipated dimensional change is expected. Any abnormal surface condition may be an indication of an aging effect for metals and for polymers. For flexible materials to be considered acceptable, the inspection results should indicate that the flexible polymer material is in “as new” condition (e.g., the hardness, flexibility, physical dimensions, and color of the material are		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
unchanged from when the material was new). Cracks should be absent within the material. For rigid polymers, surface changes affecting performance, such as erosion, cracking, crazing, checking, and chalks, are subject to further investigation. Acceptance criteria include design standards, procedural requirements, current licensing basis, industry codes or standards, and engineering evaluation.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
The site corrective actions program, quality assurance procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
As discussed in the GALL Report, the staff finds the requirements 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
As discussed in the GALL Report, the staff finds the requirements 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
Inspections of internal surfaces during the performance of periodic surveillance and maintenance activities have been in effect at many utilities in support of plant component reliability programs. These activities have proven effective in maintaining the material condition of plant systems, structures, and components. The elements that comprise these inspections (e.g., the scope of the inspections and inspection techniques) are consistent with industry practice and staff expectations. However, because the inspection frequency is plant-specific and depends on the plant operating experience, the applicant's plant-specific operating experience or applicable generic operating experience is further evaluated for the period of extended operation. The applicant evaluates recent operating experience and provides objective evidence to support the conclusion that the effects of aging are adequately managed.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
10.1: During the audit interview at NMP-1, the program owner stated that there has been only one adverse finding under this AMP, and that was in a retired/abandoned-in-place component. The pump casing and connections showed signs of corrosion. They have put a condition report to have the pump disconnected so that it will no longer be in the scope of license renewal.	The July-Sept. 2011 System Health Report for the Service Water System at NMP-1 notes that much of the piping is in "a generally degraded condition." As a result, through-wall leaks occur at an "unacceptable" frequency of approximately one per year for 3-inch and smaller diameter piping. Furthermore, the frequency of leaks is increasing. Why was this degradation not detected under the present Preventive Maintenance AMP or other condition monitoring AMPs at NMP-1? If it was detected, why was it not addressed before the overall system had degraded to the extent indicated in the System Health Report? This raises questions as to how effectively the present AMP has been implemented. Prior to entering LTO, operating experience should be critically reviewed to detect and correct apparent weaknesses in condition monitoring AMPs such as the Preventive Maintenance Program at NMP-1.	Critically review OE prior to entering LTO to assess the effectiveness of existing condition monitoring AMPs.
10.2: The Ginna program operating experience states that significant numbers of "ACTION Reports" and "Plant Work Orders" have been generated to correct conditions identified as a result of this program activities. Program Element 6 of the Ginna Periodic Surveillance and Preventive Maintenance Program AMP states that degradations deemed to be unacceptable are addressed by the ACTION Reporting process under the Corrective Action program.	Although the OE indicates that the Ginna AMP is effective in detecting aging degradation, the large number of corrective actions that have been initiated since the plant began operation indicates that the mitigation measures to prevent degradation may not be effective or that the frequency for inspection and/or performance monitoring are not adequate. The Action Reports and the root cause evaluations should be reviewed to identify which aging effects/mechanisms and components/systems combinations are associated with these reports. In addition, check whether the current operations, maintenance, and surveillance test procedures and plant work orders were enhanced to provide explicit guidance on detection of applicable aging effects and assessment of degradation, and, if they were, what actions were taken and whether these actions were effective in timely detection of aging degradation.	See above.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI 1007933 "*Aging Assessment Field Guide*," December 2003.

EPRI 1009743, *Aging Identification and Assessment Checklist*, August 27, 2004.

INPO Good Practice TS-413, *Use of System Engineers*, INPO 85-033, May 18, 1988.

A.36 XI.M39 Lubricating Oil Analysis

The verbatim text of GALL, Rev. 2, AMP XI.M38, Lubricating Oil Analysis, is included in the following worksheet; all blue text is directly transcribed. The source of information in each line item is the result of a general review of the AMP by ANL staff; there was no separate audit report for XI.M39. The license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which did not include this AMP; neither the Ginna LRA nor the NMP-1 LRA provide an AMP on Lubricating Oil Analysis.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of the Lubricating Oil Analysis program is to ensure that the oil environment in the mechanical systems is maintained to the required quality to prevent or mitigate age-related degradation of components within the scope of this program. This program maintains oil systems contaminants (primarily water and particulates) within acceptable limits, thereby preserving an environment that is not conducive to loss of material or reduction of heat transfer. Lubricating oil testing activities include sampling and analysis of lubricating oil for detrimental contaminants. The presence of water or particulates may also be indicative of in-leakage and corrosion product buildup. Although primarily a sampling program, the lubricating oil analysis program is generally effective in monitoring and controlling impurities. This report identifies when the program is to be augmented to manage the effects of aging for license renewal. Accordingly, in certain cases identified in this report, verification of the effectiveness of the program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system.		
a.1: The Program Description section of this AMP states that "in certain cases identified in this report, verification of the effectiveness of the program is undertaken to ensure that significant degradation is not occurring and that the component's intended function is maintained during the period of extended operation. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system."	The wording here should be clarified to indicate that this one-time inspection must be repeated prior to entering each period of extended operation (i.e., another one-time inspection is required prior to subsequent license renewal).	Revise wording in program description.
Program Basis Documents and/or Supporting Documents		
The GALL, Rev. 2, AMP includes as part of the program description the guidance in 10 CFR 50, Appendix B, and ASTM Standard D 6224-		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
02. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0. That edition of GALL mentions lubricating oil, with contaminants and/or moisture, as a possible operating environment for several components, but it contains no AMP related to Lubricating Oil Analysis. Consequently, neither the Ginna LRA nor the NMP-1 LRA provide an AMP on Lubricating Oil Analysis. The Ginna LRA mentions the aging management of oil coolers in the auxiliary feedwater system in contact with contaminated lubricating oil and lists its Periodic Surveillance and Preventive Maintenance Program as the applicable AMP. The NMP-1 LRA lists a number of components in contact with lubricating oil, but makes no mention of possible contamination and identifies no aging effect.		
b.1: No specific concerns for LTO.		
Program Consistency and Commitments		
Neither the Ginna LRA nor the NMP-1 LRA provide an AMP related to Lubricating Oil Analysis. Consequently, program consistency and commitments do not apply to these LRAs.		
c.1: Neither the Ginna LRA nor the NMP-1 LRA provide an AMP related to Lubricating Oil Analysis. In addition, the NMP-1 LRA makes no mention of possible degradation of components in contact with contaminated lubricating oil.	Those plants for which license renewal was carried out under GALL, Rev. 0, may not have AMPs in place to address the issue of lubricating oil analysis and possible component degradation in contact with contaminated lubricating oil. The deficiency should be addressed prior to entering LTO.	Verify the implementation of a GALL-compliant AMP for lubricating oil analysis prior to entering LTO.
1. Scope of Program		
The program manages the aging effects of loss of material due to corrosion or reduction of heat transfer due to fouling. Components within the scope of the program include piping, piping components, and piping elements; heat exchanger tubes; reactor coolant pump elements; and any other plant components subject to aging management review that are exposed to an environment of lubricating oil (including non-water-based hydraulic oils).		
1.1: The wording of this program element does not include a description of the applicable aging-related degradation mechanisms	A sentence should perhaps be added stating that the aging effects managed by this program include loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion, as well as fouling that leads to corrosion.	Revise wording as appropriate.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2. Preventive Actions		
The Lubricating Oil Analysis program maintains oil system contaminants (primarily water and particulates) within acceptable limits.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
This program performs a check for water and a particle count to detect evidence of contamination by moisture or excessive corrosion.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
Moisture or corrosion products increase the potential for, or may be indicative of, loss of material due to corrosion and reduction of heat transfer due to fouling. The program performs periodic sampling and testing of lubricating oil for moisture and corrosion particles in accordance with industry standards. The program recommends sampling and testing of the old oil following periodic oil changes or on a schedule consistent with equipment manufacturer's recommendations or industry standards (e.g., American Society for Testing of Materials [ASTM] D 6224-02). Plant-specific operating experience also may be used to augment manufacturer's recommendations or industry standards in determining the schedule for periodic sampling and testing when justified by prior sampling results. In certain cases, as identified by the AMR Items in this report, inspection of selected components is to be undertaken to verify the effectiveness of the program and to ensure that significant degradation is not occurring and that the component intended function is maintained during the period of extended operation.		
4.1: No specific concerns for LTO.		
5. Monitoring and Trending		
Oil analysis results are reviewed to determine if alert levels or limits have been reached or exceeded. This review also checks for unusual trends.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
Water and particle concentration should not exceed limits based on equipment manufacturer's recommendations or industry standards. Phase-separated water in any amount is not acceptable.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
Pursuant to 10 CFR Part 50, Appendix B, specific corrective actions are implemented in accordance with the plant quality assurance (QA)		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
program. For example, if a limit is reached or exceeded, actions to address the condition are taken. These may include increased monitoring, corrective maintenance, further laboratory analysis, and engineering evaluation of the system. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
Site QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B		
9.1: No specific concerns for LTO.		
10. Operating Experience		
The operating experience at some plants has identified (a) water in the lubricating oil and (b) particulate contamination. However, no instances of component failures attributed to lubricating oil contamination have been identified.		
10.1: No specific concerns for LTO.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASTM D 6224-02, *Standard Practice for In-Service Monitoring of Lubricating Oil for Auxiliary Power Plant Equipment*, American Society of Testing Materials, West Conshohocken, PA, 2002.

A.37 XI.M40 Monitoring of Neutron Absorbing Materials Other Than Boraflex

The verbatim text of GALL, Rev. 2, AMP XI.M40, Monitoring of Neutron-Absorbing Material Other than Boraflex, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff. At both Ginna and NMP-1, there was a more integrated approach to spent fuel pool neutron absorbing monitoring (and not a separation between "Boraflex" XI.M22 and "other than Boraflex" XI.M40 as in GALL R.2).

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
A monitoring program is implemented to assure that degradation of the neutron-absorbing material used in spent fuel pools that could compromise the criticality analysis will be detected. The applicable aging management program (AMP) relies on periodic inspection, testing, monitoring, and analysis of the criticality design to assure that the required 5% sub-criticality margin is maintained during the period of license renewal.		
a.1: (Ginna and NMP-1 plant visit) The GALL Rev. 2 AMP is developed based on NRC LR-ISG-2009-01, "Aging Management of Spent Fuel Pool Neutron-Absorbing Material Other Than Boraflex." However, the program description needs more details of the AMP to distinguish from XI.M22 Boraflex Monitoring.	It is recommended to add following statements extracted from LR-ISG-2009-01 in the program description. Many neutron-absorbing materials, such as Boraflex, Boral, Metamic, boron steel, and Carborundum, are used in spent fuel pools. XI.M22, Boraflex Monitoring, addresses aging management of spent fuel pools that use Boraflex as neutron-absorbing material. This AMP addresses aging management of spent fuel pools that use materials other than Boraflex, such as Boral, Metamic, boron steel, and Carborundum. Recent operating experience indicates several instances of degradation and/or deformation of neutron-absorbing materials other than Boraflex in the spent fuel pools of operating reactors, as described in NRC Information Notice 2009-26, "Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool." This program assures that degradation of spent fuel pool neutron-absorbing materials other than Boraflex that could	Revise or update the program description.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	compromise the criticality analysis will be detected in the period of extended operation. The aging effects of reduction of neutron-absorbing capacity, changes of dimension that increase K_{eff}, and loss of material due to neutron-absorber degradation and radiation are managed by coupon testing, direct in situ testing, or both. Such testing includes periodic verification of boron loss through areal density measurement of coupons or through direct in situ techniques, such as measurement of boron areal density, measurement of geometric changes in the material (blistering, pitting, and bulging), and detection of gaps through blackness testing.	
Program Basis Documents and/or Supporting Documents		
NRC LR-ISG-2009-01, "Aging Management of Spent Fuel Pool Neutron-Absorbing Material Other Than Boraflex."		
b.1: No further review item was identified.		
Program Consistency and Commitments		
The AMP for both Ginna and NMP-1 plants is consistent with GALL, and there are no commitments.		
c.1: No further review item was identified.		
1. Scope of Program		
The AMP manages the effects of aging on neutron-absorbing components/materials used in spent fuel racks.		
1.1: The program element does mention what the aging effects and materials of neutron-absorbing materials are in the program scope.	The scope of program should be expanded as follows: The AMP manages the effects of aging on neutron-absorbing components/materials other than Boraflex, such as Boral, Metamic, boron steel, and Carborundum, in the spent fuel pools. Aging effects include reduction of neutron-absorbing capacity, changes of dimension that increase K_{eff}, and loss of material due to neutron-absorber degradation and radiation.	Revise or update the AMP program elements.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2. Preventive Actions		
This AMP is a condition monitoring program, and therefore, there are no preventative actions.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
For these materials, gamma irradiation and/or long-term exposure to the wet pool environment may cause loss of material and changes in dimension (such as gap formation, formation of blisters, pits and bulges) that could result in loss of neutron-absorbing capability of the material. The parameters monitored include the physical condition of the neutron-absorbing materials, such as in-situ gap formation, geometric changes in the material (formation of blisters, pits, and bulges) as observed from coupons or in situ, and decreased boron areal density, etc. The parameters monitored are directly related to determination of the loss of material or loss of neutron absorption capability of the material(s).		
3.1: (NMP-1 plant audit) The OE of this AMP states that the applicant's monitoring program should be capable of detecting aluminum concentration, blistering, and loss of plate-type Carborundum material that has occurred in industry operating experience.	A statement such as the following should be added: The parameters monitored/inspected also include aluminum concentration, blistering, and loss of plate-type Carborundum material because these aging effects have occurred in industry operating experience.	Revise or update the AMP program element.
4. Detection of Aging Effects		
The loss of material and the degradation of the neutron-absorbing material capacity are determined through coupon and/or direct in-situ testing. Such testing should include periodic verification of boron loss through areal density measurement of coupons or through direct in-situ techniques, which may include measurement of boron areal density, geometric changes in the material (blistering, pitting, and bulging), and detection of gaps through blackness testing. The frequency of the inspection and testing depends on the condition of the neutron-absorbing material and is determined and justified with plant-specific operating experience by the licensee, not to exceed 10 years.		
4.1: (NMP-1 plant audit) SER (NUREG 1900) Section 3.0.3.2.9 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels in NMP-1. The NMP-1 spent fuel pool has both Boraflex and Boral panels. The AMP may need some guidelines on the applicability of this AMP in a spent fuel pool that contains both Boraflex and materials other than Boraflex. Note that aging management of Boraflex is	Add guidelines on the applicability of this AMP in a spent fuel pool that contains both Boraflex and neutron-absorbing materials other than Boraflex.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
addressed in XI.M22, Boraflex Monitoring.		
4.2: (NMP-1 plant audit) The OE of this AMP states that the applicant's monitoring program should be capable of detecting aluminum concentration, blistering, and loss of plate-type Carborundum material that has occurred in industry OE.	A statement such as the following should be added: The program also should be capable of detecting aluminum concentration, blistering, and loss of plate-type Carborundum material as these aging effects have occurred in industry operating experience.	Revise or update the AMP program element.
5. Monitoring and Trending		
The measurements from periodic inspections and analysis are compared to baseline information or prior measurements and analysis for trend analysis. The approach for relating the measurements to the performance of the spent fuel neutron absorber materials is specified by the applicant, considering differences in exposure conditions, vented/non-vented test samples, and spent fuel racks, etc.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
Although the goal is to ensure maintenance of the 5% sub-criticality margin for the spent fuel pool, the specific acceptance criteria for the measurements and analyses are specified by the applicant.		
6.1: (NMP-1 plant audit) SER (NUREG 1900) Section 3.0.3.2.9 states that the applicant is in the process of replacing six of the eight Boraflex racks with racks made of Boral panels in NMP-1. The NMP-1 spent fuel pool has both Boraflex and Boral panels. The AMP may need some guidelines and clarification on the acceptance criteria of 5% subcriticality margin of the spent fuel racks for a spent pool containing both Boraflex and non-Boraflex (Boral) neutron-absorbing materials.	Guidance should be provided on the acceptance criteria for spent fuel racks for a spent pool containing both Boraflex and non-Boraflex (Boral) neutron-absorbing materials.	Update or revise the AMP program element.
7. Corrective Actions		
Corrective actions are initiated if the results from measurements and analysis indicate that the 5% sub-criticality margin cannot be maintained because of current or projected future degradation of the neutron-absorbing material. Corrective actions may consist of providing additional neutron-absorbing capacity with an alternate material, or applying other options, which are available to maintain the sub-criticality margin. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Applicants for license renewal reference plant-specific operating experience and industry experience to provide reasonable assurance that the program is able to detect degradation of the neutron absorbing material in the applicant's spent fuel pool. Some of the industry operating experience that should be included is listed below: 1. Loss of material from the neutron absorbing material has been seen at many plants, including loss of aluminum, which was detected by monitoring the aluminum concentration in the spent fuel pool. One instance of this was documented in the Vogtle LRA Water Chemistry Program B.3.28. 2. Blistering has also been noted at many plants. Examples include blistering at Seabrook and Beaver Valley. 3. The significant loss of neutron-absorbing capacity of the plate-type Carborundum material has been reported at Palisades. The applicant should describe how the monitoring program described above is capable of detecting the aforementioned degradation mechanisms.		
10.1: No further review item was identified.		

References

NRC LR-ISG-2009-01, *Aging Management of Spent Fuel Pool Neutron-Absorbing Materials Other Than Boraflex*, 2010.

NRC Letter from Christopher J. Schwarz, Entergy Nuclear Operations, Inc., Palisades Nuclear Plant, to the U.S. Nuclear Regulatory Commission, Commitments to Address Degraded Spent Fuel Pool Storage Rack Neutron Absorber, August 27, 2008, (ADAMS Accession No. ML082410132).

NRC Letter from Kevin L. Ostrowski, FirstEnergy Nuclear Operating Company, to the U.S. Nuclear Regulatory Commission, Supplemental Information for the Review of the Beaver Valley Power Station, Units 1 and 2, License Renewal Application (TAC Nos. MD6593 and MD6594) and License Renewal Application Amendment No. 34, January 19, 2009, (ADAMS Accession No. ML090220216).

NRC Information Notice 2009-26, *Degradation of Neutron-Absorbing Materials in the Spent Fuel Pool*, U.S. Nuclear Regulatory Commission, October 28, 2009.

A.38 XI.M41 Buried Underground Piping and Tanks

The verbatim text of GALL, Rev. 2, AMP XI.M41, Buried Underground Piping and Tanks, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This is a comprehensive program designed to manage the aging of the external surfaces of buried and underground piping and tanks and to augment other programs that manage the aging of internal surfaces of buried and underground piping and tanks. It addresses piping and tanks composed of any material, including metallic, polymeric, cementitious, and concrete materials. This program manages aging through preventive, mitigative, and inspection activities. It manages all applicable aging effects such as loss of material, cracking, and changes in material properties. Depending on the material, preventive and mitigative techniques may include the material itself, external coatings for external corrosion control, the application of cathodic protection, and the quality of backfill utilized. Also, depending on the material, inspection activities may include electrochemical verification of the effectiveness of cathodic protection, non-destructive evaluation of pipe or tank wall thicknesses, hydrotesting of the pipe, and visual inspections of the pipe or tank from the exterior as permitted by opportunistic or directed excavations. Management of aging of the internal surfaces of buried and underground piping and tanks is accomplished through the use of other aging management programs (e.g., Open Cycle Cooling Water System (AMP XI.M20), Closed Treated Water System (AMP XI.M21A), Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components (AMP XI.M38), Fuel Oil Chemistry (AMP XI.M30), Fire Water System (AMP XI.M27), or Water Chemistry (AMP XI.M2)). However, in some cases, this external surface program may be used in conjunction with the internal surface aging management programs to manage the aging of the internal surfaces of buried and underground piping and tanks. This program does not address selective leaching. The Selective Leaching of Materials (AMP XI.M33) is applied in addition to this program for applicable materials and environments. The terms “buried” and “underground” are fully defined in Chapter IX of the GALL Report. Briefly, buried piping and tanks are in direct contact with soil or concrete (e.g., a wall penetration). Underground piping and tanks are below grade but are contained within a tunnel or vault such that they are in contact with air and are located where access for inspection is restricted.		
a.1: No specific concerns for LTO.		
Program Basis Documents and/or Supporting Documents		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The GALL, Rev. 2, AMP includes as part of the program description, the guidance in 10 CFR 50, Appendix B; 49 CFR 195, subpart E; American Association of State Highway and Transportation Officials (AASHTO) R 27; ASME Boiler and Pressure Vessel Code, Section IX; NACE Recommended Practice RP0285-2002; NACE Standard Practice SP0169-2007; NFPA Standard 24; and NFPA Standard 25. However, the license renewal process for both Ginna and NMP-1 was carried out under GALL, Rev. 0, which recommended the use of NACE standards RP-0285-95 and RP-0169-96. The Ginna LRA states that they did not employ these standards, or credit the surveillance and preventive measures referenced in these standards, as aging management programs their Buried Piping and Tanks Inspection AMP (B2.1.7) and their Buried Piping and Tanks Surveillance AMP (B2.1.8). Instead, they relied upon existing monitoring, surveillance, and mitigation AMPs to manage aging in underground piping and tanks. The NMP-1 amended LRA identifies their Buried Piping and Tanks Inspection AMP (B2.1.22) to manage the aging effects of concern here. This new AMP does not list any specific program basis or supporting documentation.		
b.1: No specific concerns for LTO.		
Program Consistency and Commitments		
The Ginna Buried Piping and Tanks Inspection AMP (B2.1.7) and Buried Piping and Tanks Surveillance AMP (B2.1.8) do not state any exceptions or enhancements to GALL, Rev. 0, nor are any did they identify any commitments identified. After Ginna clarified that the inspection of buried tanks and piping is carried out under the Ginna One-Time Inspection Program, the NRC staff found the Ginna Buried Piping and Tanks Inspection Program to be acceptable. The Buried Piping and Tanks Surveillance Program was found to be acceptable as submitted in the LRA. The NMP-1 Buried Piping and Tanks Inspection AMP (B2.1.22) identifies no exceptions or enhancements to GALL, Rev. 0, AMP XI.M34. The following commitment (no. 24 on p. A1-40 of the amended NMP-1 LRA) states: “Develop and implement a Buried Piping and Tank Inspection Program which includes a requirement that if an opportunistic inspection does not occur within the first ten years of extended operation, NMPNS will excavate a representative sample for the purpose of inspection.” This commitment is to be met prior to entering the period of extended operation. In response to an RAI concerning NPD focused inspection only during the 10-year period of extended operation and not during the 10-year period prior to extended operation, NMP-1 responded that that its Buried Piping and Tanks Inspection Program was incomplete and that the LRA will be amended to address the need for possible focused inspections during the 10-year period prior to extended operation. With this clarification, the NRC staff found the NMP-1 Buried Piping and Tanks Inspection AMP to be acceptable.		
c.1: No specific concerns for LTO.		
1. Scope of Program		
This program is used to manage the effects of aging for buried and underground piping and tanks constructed of any material including metallic, polymeric, cementitious, and concrete materials. The program addresses aging effects such as loss of material, cracking, and changes in material properties. Typical systems in which buried and underground piping and tanks may be found include service water piping and components, condensate storage transfer lines, fuel oil and lubricating oil lines, fire protection piping and piping components		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
(fire hydrants), and storage tanks. Loss of material due to corrosion of piping system bolting within the scope of this program is managed using this program. Other aging effects associated with piping system bolting are managed through the use of the Bolting Integrity Program (AMP XI.M18).		
1.1: No specific concerns for LTO.		
2. Preventive Actions		
Preventive actions utilized by this program vary with the material of the tank or pipe and the environment (air, soil, or concrete) to which it is exposed. These actions are outlined below: **a. Preventive Actions – Buried Piping and Tanks** i. Preventive actions for buried piping and tanks are conducted in accordance with Table 2a in GALL, Rev. 2 AMP XI.M41 and its accompanying footnotes. ii. Fire mains are installed in accordance with National Fire Protection Association (NFPA) Standard 24. Preventive actions for fire mains beyond those in NFPA 24 need not be provided if the system undergoes either a periodic flow test in accordance with NFPA 25 or the activity of the jockey pump (or equivalent equipment or parameter) is monitored as described in program element 4 of this AMP. iii. When referenced, NACE SP0169-2007 is to be used in its entirety excepting Section 3, Determination of Need for External Corrosion Control. Use of Section 3 of the standard constitutes an exception to this AMP. Exceptions to the AMP related to the need for external corrosion control should include an analysis of issues such as those described in National Cooperative Highway Research Program (NCHRP) Report 408, "Corrosion of Steel Piling in Non Marine Applications and American Association of State Highway and Transportation Officials (AASHTO) Standard R 27." **b. Preventive Actions – Underground Piping and Tanks** i. Preventive actions for underground piping and tanks are conducted in accordance with Table 2b in GALL, Rev. 2 AMP XI.M41and its accompanying footnotes.		
2.1: No specific concerns for LTO.		
3. Parameters Monitored/Inspected		
The aging effects addressed by this AMP are changes in material properties of polymeric materials, loss of material due to all forms of corrosion and, potentially, cracking due to stress corrosion cracking. Changes in material properties are monitored by manual examinations. Loss of material is monitored by visual appearance of the exterior of the piping or tank and wall thickness of the piping or tank. Wall thickness is determined by a non-destructive examination technique such as ultrasonic testing (UT). Two additional parameters, the pipe-to-soil potential and the cathodic protection current, are monitored for steel, copper, and aluminum piping and tanks in contact		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
with soil to determine the effectiveness of cathodic protection systems and, thereby, the effectiveness of corrosion mitigation.		
3.1: No specific concerns for LTO.		
4. Detection of Aging Effects		
Methods and frequencies used for the detection of aging effects vary with the material and environment of the buried and underground piping and tanks. These methods and frequencies are outlined below. **a. Opportunistic Inspections** *i. All buried and underground piping and tanks, regardless of their material of construction, are inspected by visual means whenever they become accessible for any reason. The information in paragraph f of this program element is applied in the event deterioration of piping or tanks is observed.* **b. Directed Inspections – Buried Pipe** i. *Directed inspections for buried piping are conducted in accordance with Table 4a in GALL, Rev. 2 AMP XI.M41and its accompanying footnotes. Modifications to this table may be appropriate if exceptions to program Element 2, Preventive Actions, are taken or in response to plant specific operating experience.* ii. *Unless otherwise indicated, directed inspections as indicated in Table 4a will be conducted during each 10-year period beginning 10 years prior to the entry into the period of extended operation.* iii. *Inspection locations are selected based on risk (based on susceptibility to degradation and consequences of failure). Characteristics such as coating type, coating condition, cathodic protection efficacy, backfill characteristics, soil resistivity, pipe contents, and pipe function are considered. Piping systems that are backfilled using controlled low strength material generally experience lower corrosion rates and may be more difficult to excavate than piping systems backfilled using compacted aggregate fill. As a result, piping systems that are backfilled using compacted aggregate should generally be given a higher inspection priority than comparable systems that are completely backfilled using controlled low strength material. For many piping systems, External Corrosion Direct Assessment (ECDA) as described in NACE Standard Practice SP0502-2010 has been demonstrated to be an effective method for use in the identification of pipe locations that merit further inspection.* iv. *Visual inspections are supplemented with surface and/or volumetric non-destructive testing (NDT) if significant indications are observed.* v. *Opportunistic examinations of non leaking pipes may be credited toward these direct examinations if the location selection criteria in item iii, above, are met.* vi. At multi-unit sites, individual inspections of shared piping may be credited for only one unit. vii. Visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
changes in material properties. viii. The use of guided wave ultrasonic or other advanced inspection techniques is encouraged for the purpose of determining those piping locations that should be inspected but may not be substituted for the inspections listed in the table. ix. For the purpose of this program element, fire mains will be considered to be code class/safety-related piping and inspected as such unless they are subjected to either a flow test as described in section 7.3 of NFPA 25 at a frequency of at least one test in each 1-year period or the activity of the jockey pump (or equivalent equipment or parameter) is monitored on an interval not to exceed 1 month. At a minimum, a flow test is conducted by the end of the next refueling outage or as directed by current licensing basis, whichever is shorter, when unexplained changes in jockey pump activity (or equivalent equipment or parameter) are observed. x. Inspection as indicated in either (A) or (B) below may be performed in lieu of the inspections contained in Table 4a for either code class/safety significant or hazmat piping or both: A. At least 25% of the code class/safety-related or hazmat piping or both constructed from the material under consideration is hydrostatically tested in accordance with 49 CFR 195 subpart E on an interval not to exceed 5 years. B. At least 25% of the code class/safety-related or hazmat piping or both constructed from the material under consideration is internally inspected by a method capable of precisely determining pipe wall thickness. The inspection method must be capable of detecting both general and pitting corrosion and must be qualified by the applicant and approved by the staff. As of the effective date of this document, guided wave ultrasonic examinations do not meet this paragraph. Internal inspections are to be conducted at an interval not to exceed 5 years. Consideration should be given to NACE SP0169-2007 sections 6.1.2 and 6.3.3. **c. Directed Inspections – Underground Pipe** i. Directed inspections for underground piping are conducted in accordance with Table 4b and its accompanying footnotes. ii. Unless otherwise indicated, directed inspections as indicated in Table 4b in GALL, Rev. 2 AMP XI.M41will be conducted during each 10-year period beginning 10 years prior to the entry into the period of extended operation. iii. Inspection locations are selected based on risk (based on susceptibility to degradation and consequences of failure). Characteristics such as coating type, coating condition, exact external environment, pipe contents, pipe function, and flow characteristics within the pipe, are considered. iv. Underground pipes are inspected visually to detect external corrosion and by a volumetric technique such as UT to detect internal corrosion. v. Opportunistic examinations may be credited toward these direct examinations if the location selection criteria in item iii, above, are met. vi. At multi-unit sites, individual inspections of shared piping may be credited for only one unit. vii. When access permits, visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other changes in material properties.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
viii. The use of guided wave ultrasonic or other advanced inspection techniques is encouraged for the purpose of determining those piping locations that should be inspected but may not be substituted for the inspections listed in the table. ix. For the purpose of this program element, fire mains will be considered to be code class/safety-related piping and inspected as such unless they are subjected to either a flow test as described in section 7.3 of NFPA 25 at an frequency of at least one test in each 1-year period or the activity of the jockey pump (or equivalent equipment or parameter) is monitored on an interval not to exceed 1 month. At a minimum, a flow test is conducted by the end of the next refueling outage or as directed by current licensing basis, whichever is shorter, when unexplained changes in jockey pump activity (or equivalent equipment or parameter) are observed. x. Inspection as indicated in (A), and (B) below may be performed in lieu of the inspections contained in Table 4a for either code class/safety significant or hazmat piping or both: A. At least 25% of the code class/safety-related or hazmat piping or both constructed from the material under consideration is hydrostatically tested in accordance with 49 CFR 195 subpart E on an interval not to exceed 5 years. B. At least 25% of the code class/safety-related or hazmat piping or both constructed from the material under consideration is internally inspected by a method capable of precisely determining pipe wall thickness. The inspection method must be capable of detecting both general and pitting corrosion and must be qualified by the applicant and approved by the staff. As of the effective date of this document, guided wave ultrasonic examinations do not meet this paragraph. Internal inspections are to be conducted at an interval not to exceed 5 years. Consideration should be given to SP0169-2007 sections 6.1.2 and 6.3.3. **d. Directed Inspections – Buried Tanks** i. Directed inspections for buried tanks are conducted in accordance with Table 4c in GALL, Rev. 2 AMP XI.M41 and its accompanying footnotes. Modifications to this table may be appropriate if exceptions to program Element 2, preventive actions, are taken or in response to plant specific operating experience. ii. Directed inspections as indicated in Table 4c will be conducted during each 10-year period beginning 10 years prior to the entry into the period of extended operation. iii. Each buried tank is examined if it is Code Class/safety-related or contains hazardous materials as defined in footnote 5 to Table 4a and it is constructed from a material for which an examination is indicated in Table 4c. iv. Examinations may be conducted from the external surface of the tank using visual techniques or from the internal surface of the tank using volumetric techniques. If the tank is inspected from the external surface, a minimum 25% coverage is required. This area must include at least some of both the top and bottom of the tank. If the tank is inspected internally by UT, at least one measurement is required per square foot of tank surface. UT measurements are distributed uniformly over the surface of the tank. If the tank is inspected internally by another volumetric technique, at least 90% of the surface of the tank must be inspected. Double wall tanks may be examined by monitoring the annular space for leakage. v. Visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
changes in material properties. vi. Opportunistic examinations may be credited toward these direct examinations. **e. Directed Inspections – Underground Tanks** i. Directed inspections for underground tanks are conducted in accordance with Table 4d in GALL, Rev. 2 AMP XI.M41 and its accompanying footnotes. ii. Directed inspections as indicated in Table 4d will be conducted during each 10-year period beginning 10 years prior to the entry into the period of extended operation. iii. Each underground tank that is Code Class/safety-related or contains hazardous materials as defined in footnote 5 to Table 4a and is constructed from a material for which an examination is indicated in Table 4d is examined. iv. Examinations may be conducted from the external surface of the tank using visual techniques or from the internal surface of the tank using volumetric techniques. If the tank is inspected from the external surface, a minimum 25% coverage is required. This area must include at least some of both the top and bottom of the tank. If the tank is inspected internally by UT, at least one measurement is required per square foot of tank surface. If the tank is inspected internally by another volumetric technique, at least 90% of the surface of the tank must be inspected. Double wall tanks may be examined by monitoring the annular space for leakage. v. Tanks that cannot be examined using volumetric examination techniques are examined visually from the outside. vi. When access permits, visual inspections for polymeric materials are augmented with manual examinations to detect hardening, softening, or other changes in material properties. vii. Opportunistic examinations may be credited toward these direct examinations. **f. Adverse indications** i. Adverse indications observed during monitoring of cathodic protection systems or during inspections are entered into the plant corrective action program. Adverse indications that are the result of inspections will result in an expansion of sample size as described in item iv., below. Adverse indications that are the result of monitoring of a cathodic protection system may warrant increased monitoring of the cathodic protection system and/or additional inspections. Examples of adverse indications resulting from inspections include leaks, material thickness less than minimum, the presence of coarse backfill with accompanying coating degradation within 6 inches of a coated pipe or tank (see Table 2a Footnotes 5 and 6), and general or local degradation of coatings so as to expose the base material. ii. Adverse indications that fail to meet the acceptance criteria described in program element 6 of this AMP will result in the repair or replacement of the affected component. iii. An analysis may be conducted to determine the potential extent of the degradation observed. Expansion of sample size may be limited by the extent of piping or tanks subject to the observed degradation mechanism.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
iv. If adverse indications are detected, inspection sample sizes within the affected piping categories are doubled. If adverse indications are found in the expanded sample, the inspection sample size is again doubled. This doubling of the inspection sample size continues as necessary.		
4.1: According to Ginna SER Section 3.3.2.3.1, Ginna relies upon its Periodic Surveillance and Preventive Maintenance Program to carry out inspections of underground piping and tanks, and these inspections are performed on an opportunistic basis. No directed periodic inspections are indicated in the Ginna AMP, as confirmed by the Ginna program owner during audit interview. (Note that the NMP-1 LRA includes a commitment to excavate degradation-susceptible areas to perform focused inspections if an opportunistic inspection has not occurred within the past 10 years at the time of initial license renewal.)	GALL, Rev. 2, AMP XI.M41 calls for directed inspections at 10-year intervals, beginning 10 years prior to entering into the initial period of extended operation. Before entering LTO and during LTO, it will be necessary to confirm that directed inspections have been performed at the intervals specified in current GALL guidance.	Verify inspection intervals for underground piping and tanks before entering LTO and during LTO.
5. Monitoring and Trending		
For piping and tanks protected by cathodic protection systems, potential difference and current measurements are trended to identify changes in the effectiveness of the systems and/or coatings. If aging of fire mains is managed through monitoring jockey pump activity (or similar parameter), jockey pump activity (or similar parameter) is trended to identify changes in pump activity that may be the result of increased leakage from buried fire main piping.		
5.1: No specific concerns for LTO.		
6. Acceptance Criteria		
The principal acceptance criteria associated with the inspections contained with this AMP follow: a. Criteria for soil-to-pipe potential are listed in NACE RP0285-2002 and SP0169-2007. b. For coated piping or tanks, there should be either no evidence of coating degradation or the type and extent of coating degradation should be insignificant as evaluated by an individual possessing a NACE operator qualification or otherwise meeting the qualifications to evaluate coatings as contained in 49 CFR 192 and 195. c. If coated or uncoated metallic piping or tanks show evidence of corrosion, the remaining wall thickness in the affected area is determined to ensure that the minimum wall thickness is maintained. This may include different values for large area minimum wall thickness, and local area wall thickness.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
d. Cracking or blistering of nonmetallic piping is evaluated. e. Cementitious or concrete piping may exhibit minor cracking and spalling provided there is no evidence of leakage or exposed rebar or reinforcing “hoop” bands. f. Backfill is in accordance with specifications described in program element 2 of this AMP. g. Flow test results for fire mains are in accordance with NFPA 25 section 7.3. h. For hydrostatic tests, the condition “without leakage” as required by 49 CFR 195.302 may be met by demonstrating that the test pressure, as adjusted for temperature, does not vary during the test. i. Changes in jockey pump activity (or similar parameter) that cannot be attributed to causes other than leakage from buried piping are not occurring.		
6.1: No specific concerns for LTO.		
7. Corrective Actions		
The site corrective actions program, quality assurance (QA) procedures, site review and approval process, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. The staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions, confirmation process, and administrative controls.		
7.1: No specific concerns for LTO.		
8. Confirmation Process		
The confirmation process ensures that preventive actions are adequate to manage the aging effects and that appropriate corrective actions have been completed and are effective. The confirmation process for this program is implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
8.1: No specific concerns for LTO.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9.1: No specific concerns for LTO.		
10. Operating Experience		
Operating experience shows that buried and underground piping and tanks are subject to corrosion. Corrosion of buried oil, gas, and hazardous materials pipelines have been adequately managed through a combination of inspections and mitigative techniques, such as those prescribed in NACE		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
SP0169-2007 and NACE RP0285- 2002. Given the differences in piping and tank configurations between transmission pipelines and those in nuclear facilities, it is necessary for applicants to evaluate both plant-specific and nuclear industry operating experience and to modify its aging management program accordingly. The following industry experience may be of significance to an applicant's program: a. In February 2005, a leak was detected in a 4-inch condensate storage supply line. The cause of the leak was microbiologically influenced corrosion or under deposit corrosion. The leak was repaired in accordance with the American Society of Mechanical Engineers (ASME) Section XI, "Repair/Replacement Plan." b. In September 2005, a service water leak was discovered in a buried service water header. The header had been in service for 38 years. The cause of the leak was either failure of the external coating or damage caused by improper backfill. The service water header was relocated above ground. c. In October 2007, degradation of essential service water piping was reported. The riser pipe leak was caused by a loss of pipe wall thickness due to external corrosion induced by the wet environment surrounding the unprotected carbon steel pipe. The corrosion processes that caused this leak affected all eight similar locations on the essential service water riser pipes within vault enclosures and had occurred over many years. d. In February 2009, a leak was discovered on the return line to the condensate storage tank. The cause of the leak was coating degradation probably due to the installation specification not containing restrictions on the type of backfill allowing rocks in the backfill. The leaking piping was also located close to water table. e. In April 2009, a leak was discovered in an aluminum pipe where it went through a concrete wall. The piping was for the condensate transfer system. The failure was caused by vibration of the pipe within its steel support system. This vibration led to coating failure and eventual galvanic corrosion between the aluminum pipe and the steel supports. f. In June 2009, an active leak was discovered in buried piping associated with the condensate storage tank. The leak was discovered because elevated levels of tritium were detected. The cause of the through-wall leaks was determined to be the degradation of the protective moisture barrier wrap that allowed moisture to come in contact with the piping resulting in external corrosion.		
10.1: No specific concerns for LTO.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

A.39 X.M1 Fatigue Monitoring

The verbatim text of GALL, Rev. 2, AMP X.M1, Fatigue Monitoring, for managing TLAAs, are included in the following worksheet. The information source for line items based on visits to the Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Fatigue usage factor is a computed mechanical parameter suitable for gauging fatigue damage in components subjected to fluctuating stresses. Crack initiation is assumed to have started in a structural component when the fatigue usage factor at a surface point of the component reaches the value of 1, the design limit on fatigue. In order not to exceed the design limit on fatigue usage, the aging management program (AMP) monitors and tracks the number of critical thermal and pressure transients for the selected components. The program also verifies that the severity of the monitored transients is bounded by the design transient definition for which they are classified. The AMP addresses the effects of the reactor coolant environment on component fatigue life (to determine an environmentally-adjusted cumulative usage factor, or CUF_{en}) by assessing the impact of the reactor coolant environment on a set of sample critical components for the plant. Examples of critical components are identified in NUREG/CR-6260. Environmental effects on fatigue for these critical components may be evaluated using one of the following sets of formulae: • Carbon and Low Alloy Steels ◦ Those provided in NUREG/CR-6583, using the applicable ASME Section III fatigue design curve. ◦ Those provided in Appendix A of NUREG/CR-6909, using either the applicable ASME Section III fatigue design curve or the fatigue design curves for carbon and low alloy steel provided in NUREG/CR-6909 (Figures A.1 and A.2, respectively, and Table A.1). ◦ A staff approved alternative. • Austenitic Stainless Steels ◦ Those provided in NUREG/CR-5704, using the applicable ASME Section III fatigue design curve. ◦ Those provided in NUREG/CR-6909, using the fatigue design curve for austenitic stainless steel provided in NUREG/CR-6909 (Figure A.3 and Table A.2). ◦ A staff approved alternative.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
• Nickel Alloys ◦ Those provided in NUREG/CR-6909, using the fatigue design curve for austenitic stainless steel provided in NUREG/CR-6909 (Figure A.3 and Table A.2). ◦ A staff approved alternative. Any one option may be used for calculating the CUF_{en} for each material.		
a.1: (NMP-1 plant visit) In addition to tracking all design transients, this AMP calculates and monitors the fatigue CUF values of all fatigue sensitive locations (i.e., with high CUF values), including environmental effects for at least the sample of critical components as defined in NUREG/CR-6260 for older vintage BWR (i.e., NMP-1). The selection of critical locations is based on one or more of the following: 1. High fatigue usage (i.e., 40-year CUF ≥0.4), 2. Field experience suggesting a fatigue concern, 3. Importance to accident scenarios (e.g., core spray nozzle), and 4. Identified in NUREG/CR-6260. NMP-1 has decided to use the Fatigue Pro fatigue monitoring software to ensure that actual fatigue CUFs will not exceed the design limit for the life of the plant, including the period of extended operation.	The criteria defined by the applicant for selecting the critical fatigue locations that are monitored and tracked by this AMP are considered a good practice or strength of the AMP. The effects of the coolant environment on component fatigue life are addressed by assessing the impact of the reactor coolant environment on a set of sample critical components for the plant. The environmentally adjusted fatigue CUF can be calculated by multiplying the regular fatigue CUF, evaluated in accordance with the ASME Section III guidelines, in an air environment, by the environmental fatigue life correction factor, F_{en}. Section 4.3.2.1.3 of the license renewal SRP states that these critical components should include, as a minimum, those identified in NUREG/CR-6260. Applicants should consider adding additional component locations if they are considered to be more limiting than those considered in NUREG/CR-6260. It would be helpful to include such guidance in the GALL AMP for selecting any additional component locations that may be included in the sample of critical components for which the effects of the coolant environment are incorporated in the fatigue CUF analyses.	Revise the program description to include such guidance.
a.2: GALL, Rev. 1, AMP X.M1 implicitly indicates that the program scope is limited to the reactor coolant pressure boundary components as indicated in its title, "X.M1 Metal Fatigue of Reactor Coolant Pressure Boundary." By contrast, the scope of the program	The program description should clearly mention that this AMP not only monitors TLAAs associated with metal fatigue of reactor coolant pressure boundary, but may also monitor other TLAAs, especially any component that has a CUF calculation.	Revise the program description of scope of program to

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
section of GALL, Rev. 2, AMP X.M1 states that the scope includes those components that have been identified to have a fatigue TLAA.		include this clarification.
Program Basis Documents and/or Supporting Documents		
The following documents provide either the basis for this AMP or additional guidance for the AMP: (a) The sample of critical components, for which the effects of reactor coolant environment on the fatigue CUF needs to be evaluated, is in alignment with the sample locations identified in NUREG/CR-6260. (b) The expressions for calculating environmental fatigue life correction factor, F_{en}, for carbon and low-alloy steels, austenitic SSs, and nickel alloys are contained in NUREG/CR-6909.		
b.1: (NMP-1 plant visit) The expressions for calculating environmental fatigue life correction factor, F_{en}, in earlier revisions of the GALL report were presented in NUREG/CR-6583 for carbon and low-alloy steels and NUREG/CR-5704 for austenitic SSs. However, the expressions for nickel alloys were not included. It was generally believed that since the CUF for nickel alloys was calculated using the SS air curves, the F_{en} for SSs would also be used to incorporate environmental effects.	In the absence of a F_{en} expression for nickel alloys in earlier versions of the GALL AMP, most applicants have used a F_{en} expression that was not approved or endorsed by the staff. It would be extremely helpful to provide guidance on how the licensees should apply the recommendations of new revisions of license renewal guidance documents to the existing components that were reviewed under previous revisions of the license renewal guidance documents. Examples of such guidance may include the guidance described in NUREG/CR-6909 for calculating F_{en} for nickel alloys.	Include guidance for applying the latest LR guidance to SSCs reviewed under earlier versions of LR guidance.
Program Consistency and Commitments		
NMP-1 made the following enhancements to make its AMP consistent with the guidance of the GALL AMP X.M1. 1. The following commitments were made to implement the Fatigue Pro fatigue-monitoring program. (a) Fatigue Pro fatigue-monitoring software will be implemented for those locations where additional fatigue analysis is required to accurately determine CUF and maintain adequate margin. (b) Transients contributing to fatigue CUF of the RPV FW nozzle will be tracked using stress-based fatigue methodology. (c) Transients contributing to fatigue CUF of the Class 1 system will be tracked using cycle-based fatigue methodology. (d) For the critical reactor vessel component locations listed in LRA Tables 4.3.3 and 4.3.4, CUF is computed using the cycle-based or stress-based fatigue method. (e) Develop baseline CUF in air (since NMP-1 is a B31.1 plant, CUF values do not exist for the Class 1 piping) for the following NMP-1 piping systems: FW/HPCI, core spray, RWCU within the reactor coolant pressure boundary, reactor		

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recirculation and associated shutdown cooling system lines. If the baseline CUF exceeds 0.4, that location may require monitoring to ensure compliance over the PEO. (f) The NMP-1 program will track transients that are specific to the emergency cooling system to update the baseline CUF for the emergency condensers. 2. Assess the impact of environmental effects on a sample of critical locations, including those in NUREG/CR-6260, by applying the environmental correction factor F_{en} to existing and future fatigue analyses.		
c.1: Regarding the 2nd item, the selection of critical fatigue-sensitive locations for which environmental effects are to be included in the fatigue CUF analyses is often based on a threshold CUF of 0.4 in air, below which a location is not considered to be a critical fatigue-sensitive location that requires evaluation of environmental effects and included in the fatigue monitoring program. This criterion is often used in BWRVIP documents. In addition, the NMP-1 LRA states that those locations whose baseline CUF for 40 years is less than 40% of the limiting value (i.e., CUF = 0.4) will not require additional analysis, since in these cases a margin of at least 50% still exists for 60-year operation.	However, F_{en} values for SSs in HWC are typically greater than 3 (i.e., including environmental effects the CUF would exceed the design limit). Therefore, a criterion based on a CUF of 0.4 is non-conservative, and unless the validity of this threshold can be demonstrated, it should not be used for selecting fatigue-sensitive locations. It should definitely not be used to identify fatigue sensitive locations in reactor core internal components, because the effect of neutron irradiation on fatigue crack initiation is not well known.	If this and comment **a.1** are considered acceptable, revise the program description to include appropriate guidance.
1. Scope of Program		
The scope includes those components that have been identified to have a fatigue TLAA. The program monitors and tracks the number of critical thermal and pressure transients for the selected components. The program ensures the fatigue usage remaining within the allowable limit, thus minimizing fatigue cracking of metal components caused by anticipated cyclic strains in the material. For purposes of monitoring and tracking, applicants should include, for a set of sample reactor coolant system components, fatigue usage calculations that consider the effects of the reactor water environment. This sample set should include the locations identified in NUREG/CR-6260 and additional plant-specific component locations in the reactor coolant pressure boundary if they may be more limiting than those considered in NUREG/CR-6260.		
1.1: Several AAIs are listed in the SERs for the various BWRVIP documents listed in the GALL AMPs for BWRs. The AAIs that involve fatigue TLAAs are core spray internals, core plate DP/SLC system penetrations, LPCI coupling, and lower plenum internals. In addition, AAI #4	All BWR licensees have to address these AAIs unless they have received NRC approval for deviation from the BWRVIP guidance. To ensure consistency in AMP implementation, it would be helpful to include some guidance for all licensees who have referenced any of	Revise or update the scope of program to include such

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for BWRVIP-74-A requests that the applicant verify the number of cycles assumed in the original fatigue design is conservative to assure that the estimated fatigue usage for 60 years of plant operation is not underestimated. Furthermore, a LR applicant must address environmental fatigue for the following components: nozzles, penetrations, safe-ends, closure studs, vessel support skirt, and vessel external attachments.	these BWRVIP documents in its AMPs, to address the AAIs that involve fatigue TLAAs. In addition, please note that the closure studs, vessel support skirt and vessel external attachments are exposed to the air environment inside the containment and are therefore not exposed to the reactor coolant environment. As a result, evaluation of environmental effects is not applicable to these locations.	guidance.
1.2: As discussed above, AAI #4 for BWRVIP-74-A recommends fatigue CUF TLAAs for the following six components: nozzles, penetrations, safe-ends, closure studs, vessel support skirt, and vessel external attachments.	For BWRs, irrespective of whether these TLAAs were in the licensees CLB or do not meet criterion #6 of 10 CFR 54.3, the licensee should include these six TLAAs in its licensing basis, unless the licensee has received NRC approval for deviation from the BWRVIP guidance. The Ginna updated final safety analysis report (UFSAR) indicates projected CUF of 0.979 for the reactor vessel external support brackets.	Revise the scope of program to include this clarification.
1.3: (Ginna plant visit) Although the program basis document indicates that the fatigue critical component is the heater penetration in the pressurizer bottom head, the component is not included in the licensee's environmental fatigue analysis addressed in the program basis document.	As discussed above, some of the criteria for identifying critical fatigue sensitive locations are a high CUF value or operating experience suggesting a high fatigue concern. Plant visits may be used for collecting such data, and if deemed necessary, may revise the scope of the program to include additional locations that need to be included in the fatigue monitoring program.	Additional information should be collected on this issue during future plant visits.
1.4: (Ginna plant visit) The program basis document indicates that industry experience (NRC Bulletin 79-13) has shown that steam generator feedwater nozzles (ASME Class 2) have experienced fatigue cracking and, therefore, Class 1 fatigue analyses have been performed for these Class 2 components. The program basis document also states that although these components are classified as ASME Class 2, the significance and consequences of fatigue cracking resulting from thermal stratification loadings warrant consideration of these components for	GALL, Rev. 2, AMP X.M1 does not include NRC Bulletin 79-13 as a reference and does not address guidance for including steam generator (SG) feedwater nozzles in the Fatigue Monitoring Program. Therefore, it is recommended that operating experience review (with fatigue evaluation) be performed to further identify ASME non-Class 1 components that potentially need to be included in the Fatigue Monitoring Program. All components with an ASME CUF calculation that are exposed to reactor water (or similar) environments should	Revise or update the scope of program to include any additional components for fatigue CUF TLAA.

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inclusion in the Fatigue Monitoring Program.	be considered. A review of the operating experience (related to fatigue indication and analysis) should be performed to identify ASME non-Class 1 components, for which environmental effect needs to be considered in the Fatigue Monitoring Program.	
2. Preventive Actions		
The program prevents the fatigue TLAAs from becoming invalid by assuring that the fatigue usage resulting from actual operational transients does not exceed the Code design limit of 1.0, including environmental effects where applicable. This could be caused by the numbers of actual plant transients exceeding the numbers used in the fatigue analyses or by the actual transient severity exceeding the bounds of the design transient definitions. However, in either of these cases, if the analysis is revised to account for the increased number or severity of transients such that the CUF value remains below 1.0, the program remains effective.		
2.1: No significant concerns or further review items were identified.		
3. Parameters Monitored/Inspected		
The program monitors all plant design transients that cause cyclic strains, which are significant contributors to the fatigue usage factor. The number of occurrences of the plant transients that cause significant fatigue usage for each component is to be monitored. Alternatively, more detailed monitoring of local pressure and thermal conditions may be performed to allow the actual fatigue usage for the specified critical locations to be calculated.		
3.1: (NMP-1 plant visit) The licensee considers both plant and industry OE when reviewing and upgrading the Fatigue Monitoring program. In 1999, such a plant experience resulted in changes to its AMP B3.2. It was discovered that the NMP-1 program was not tracking several transients that affected the reactor pressure vessel recirculation inlet and outlet nozzles. These transients were not included in the original fatigue analyses because these cycles affected the recirculation nozzles while the FW nozzles were considered as bounding nozzles for fatigue design analyses of the reactor pressure vessel. As a result, seven transients were added to the design bases transients.	The NMP-1 OE essentially indicates that for older plants (i.e., those that pre-date the BWR-6 design) the list of critical plant transients that need to be considered in the fatigue design basis analyses may not be adequate. In addition, although NMP-1 has included some additional transients in the list, it is not clear whether the 40-year fatigue CUF values of record were computed using the updated list of transients. The LRA simply states that the 40-year CUFs were calculated “based on the number and type of design basis transients” or “based on the number of anticipated transients for the original 40-year life of the plant.” Since some transients were not in the original	Include additional guidance to verify the adequacy of design basis transients. Additional information should be collected on this issue

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	design basis transients, it is not clear whether the CUF values were ever updated to include all transients. For subsequent license renewal, the design basis transients that are being tracked for these older plants should be further reviewed.	during future plant visits.
3.2: (NMP-1 plant visit) Additional relevant OE is as follows: - In general there have been no failures due to low-cycle thermal fatigue, except some cracking in the emergency cooling system due to thermal stratification. - There were several examples where critical transients were reevaluated or revised for NMP-1. There were discrepancies in the plant event log where plant events were not being tracked. For example, 7 of the 14 plant events for NMP-1 were not tracked prior to 2000.	As discussed above, for subsequent license renewal, in addition to the adequacy of the design basis transients that are being tracked by the Fatigue Monitoring program, the adequacy of monitoring and tracking the design transients should also be further reviewed, particularly during the initial period of operation.	Additional information should be collected on this issue during future plant visits.
3.3: (NMP-1 plant visit) As a result of concerns about torus attachment piping fatigue, safety relief valve (SRV) discharge was added as a monitored transient for NMP-1.	The applicant has used its plant-specific OE and updated the list of critical transients that are used for fatigue TLAAs. This transient is particularly important for all BWRs with a Mark I containment design, and could induce significant fatigue damage in SSCs affected by the transient. The parameters monitored/inspected program element may be revised to advise BWR licensees to include SRV discharge in its fatigue program evaluation.	If considered acceptable, revise this program element to include such guidance.
4. Detection of Aging Effects		
The program provides for updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components have been modified.		
4.1: The following sentences that were included in the description of this program element in GALL, Rev. 1, have been removed from Rev. 2. “The program monitors a set of sample high fatigue usage locations. This sample set includes the locations identified in NUREG/CR-6260, as	To ensure timely detection of aging effects of fatigue it is important to make sure that all critical fatigue-sensitive locations have been identified. A similar statement ensuring that all critical locations should be included in the Fatigue Monitoring program should be added in the	Revise the Element 4 description to include additional

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minimum, or proposes alternatives based on plant configuration."	description of this element.	information.
4.2: Most BWRs during the 40-year operation have switched to hydrogen water chemistry (HWC) from normal water chemistry (NWC). Some plants have also implemented NMCA to control low corrosion potentials in the reactor coolant environment and mitigate IGSCC.	For nearly all reactor structural materials, the environmental fatigue life correction factor is strongly dependent on the corrosion potential of the coolant environment. However, most LRAs do not provide any details regarding how F_{en} was calculated for the entire period of reactor operation, including the transition period, particularly when the transition period may have extended over several months or years and the water chemistry varied between HWC and NWC. A short description of the methodology for calculating F_{en} in such situations would be very helpful.	Revise the Element 4 description to include additional guidance.
4.3: Typically the fatigue CUF of some PWR components projected to 60- years of operation and including environmental effects exceeds the allowable design limit of 1.0. These components include the pressurizer surge line nozzle connection to the RCS hot leg, safety injection nozzle, and charging system nozzle. For these high-fatigue CUF components, most licensees disposition the associated TLAAs using the 10 CFR 54.21(c)(1)(iii) option for managing the aging effects of fatigue.	The only acceptable (iii) option in the GALL report is the Fatigue Monitoring program, which ensures that the fatigue CUF values of all critical fatigue-sensitive locations will be monitored and maintained below the design value, or the component will be replaced. However, instead of the Fatigue Monitoring program some licensees have proposed using an inspection program such as the guidance of MRP-227 for PWRs. Since maintaining fatigue CUF below 1.0 is a design basis requirement (and a licensing basis requirement) and the basis for license renewal is that the existing licensing basis continues to remain valid during the period of extended operation, a CUF greater than 1.0 means that the original design basis does not remain valid and the probability of forming a fatigue crack is high during extended operation. In other words, the inspection program has to manage the consequence of fatigue damage (i.e., existence of a fatigue crack). Therefore, for all fatigue sensitive locations with CUF > 1.0, a fatigue crack is assumed to exist on the very first day of restart after each inspection outage, and to ensure that the intended functions of the component will be	Revise the Element 4 description to include guidance for 54.21(c)(1)(iii) option.

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	maintained during extended operation, a program to manage the effects of fatigue needs to have the following components: (d) The component and location of maximum fatigue usage should be clearly identified. (e) Ensure that the location can be accessed for inspection and that reliable techniques exist to detect fatigue cracks. (f) To avoid uncontrolled crack extension and validate adequacy of the inspection interval, use a flaw tolerance and growth evaluation (similar to ASME Code Section XI, Non-mandatory Appendix L) to demonstrate a postulated crack remains below the critical size until the next inspection outage (i.e., 10-year interval).	
5. Monitoring and Trending		
Trending is assessed to ensure that the fatigue usage factor tends to be confined within the allowable limit during the period of extended operation, thus minimizing fatigue cracking of metal components of the reactor coolant pressure boundary caused by anticipated cyclic strains in the material.		
5.1: No significant concerns or further review items were identified.		
6. Acceptance Criteria		
The acceptance criterion is maintaining the cumulative fatigue usage below the design limit through the period of extended operation, with consideration of the reactor water environmental fatigue effects described in the program description and scope of program.		
6.1: There is some confusion regarding the acceptance criteria for high-energy line break (HELB) locations, including environmental effects. It is not clear whether the selection of HELB locations for environmentally assisted fatigue evaluations are based on an allowable CUF of 0.1, and whether those locations should be monitored to an allowable 1.0 during the PEO.	It would be prudent to update this program element to include some guidance for the acceptance criteria for HELB locations, including environmental effects.	Revise Element 6 to include guidance for HELB locations.
7. Corrective Actions		
The program provides for corrective actions to prevent the usage factor from exceeding the design code limit during the period of		

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extended operation. Acceptable corrective actions include repair of the component, replacement of the component, and a more rigorous analysis of the component to demonstrate that the design code limit will not be exceeded during the period of extended operation. Scope expansion includes consideration of other locations with the highest expected cumulative usage factors when considering environmental effects. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: With continued operation, the fatigue CUF projected to 80-years of operation and including environmental effects is likely to exceed the allowable design limit for several components, particularly PWR components. Consequently, licensees are likely to opt for the 10 CFR 54.21(c)(1) (iii) option to disposition fatigue TLAAs with high CUF values.	The description of this program element should be updated or revised to allow the use of an inspection program such as the guidance of MRP-227 for PWRs, to manage fatigue CUF TLAAs. The details are discussed in line item 4.3 above.	Revise Element 7 to include guidance for 54.21(c)(1)(iii) option.
8. Confirmation Process		
Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.		
8.1: No significant concerns or further review items were identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
The program reviews industry experience relevant to fatigue cracking. Applicable operating experience relevant to fatigue cracking is to be considered in selecting the locations for monitoring. As discussed in NRC Regulatory Issue Summary 2008-30, the use of certain simplified analysis methodology to demonstrate compliance with the ASME Code fatigue acceptance criteria could be non-conservative; therefore, a confirmatory analysis is recommended.		
10.1: No significant concerns or further review items were identified.		

References

NRC Regulatory Issue Summary 2008-30, *Fatigue Analysis of Nuclear Power Plant Components*, U.S. Nuclear Regulatory Commission, December 16, 2008.

NUREG/CR-6260, *Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components,* U.S. Nuclear Regulatory Commission, March 1995.

NUREG/CR-6909, *Effects of LWR Coolant Environments on the Fatigue Life of Reactor Materials,* U.S. Nuclear Regulatory Commission, February 2007.

Additional References

NUREG/CR-5704, *Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels*, U.S. Nuclear Regulatory Commission, April 1999.

NUREG/CR-6583, *Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels*, U.S. Nuclear Regulatory Commission, February 1998.

A.40 XI.S1 ASME Section XI, Subsection IWE

The verbatim text of GALL, Rev. 2, AMP XI.S1, ASME Section XI, Subsection IWE, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

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Program Description		
10 CFR 50.55a imposes the inservice inspection (ISI) requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, Subsection IWE, for steel containments (Class MC) and steel liners for concrete containments (Class CC). The full scope of IWE includes steel containment shells and their integral attachments, steel liners for concrete containments and their integral attachments, containment hatches and airlocks and moisture barriers, and pressure-retaining bolting. This evaluation covers the 2004 edition, as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWE, and the additional requirements specified in 10 CFR 50.55a(b)(2) constitute an existing mandated program applicable to managing aging of steel containments, steel liners of concrete containments, and other containment components for license renewal. The primary ISI method specified in IWE is visual examination (general visual, VT-3, VT-1). Limited volumetric examination (ultrasonic thickness measurement) and surface examination (e.g., liquid penetrant) may also be necessary in some instances to detect aging effects. IWE specifies acceptance criteria, corrective actions, and expansion of the inspection scope when degradation exceeding the acceptance criteria is found. Subsection IWE requires examination of coatings that are intended to prevent corrosion. AMP XI.S8 is a protective coating monitoring and maintenance program that is recommended to ensure Emergency Core Cooling System (ECCS) operability, whether or not the AMP XI.S8 is credited in AMP XI.S1. The program attributes are augmented to incorporate aging management activities, recommended in the Final Interim Staff Guidance LR-ISG-2006-01, needed to address the potential loss of material due to corrosion in the inaccessible areas of the boiling water reactor (BWR) Mark I steel containment. The attributes also are augmented to require surface examination for detection of cracking described in NRC Information Notice (IN) 92-20 and to address recommendations delineated in NUREG-1339 and industry recommendations delineated in the Electric Power Research Institute (EPRI) NP-5769, NP-5067, and TR-104213 for structural bolting. The program is also augmented to require surface examination of dissimilar metal welds of vent line bellows in accordance with examination Category E-F, as specified in the 1992 Edition of the ASME Code, Section XI, Subsection IWE. If surface examination is not possible, appropriate 10 CFR Part 50 Appendix J test may be conducted		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

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for pressure boundary components.		
a.1: (NMP-1 plant visit) One of the main objective of this AMP is aging management of the torus shell of MARK I steel containment, which has severe corrosion problems. The torus interior could be uncoated and becomes a potential moisture corrosive environment. It is important to point out the corrosive environment and elaborate torus aging management in the program description.	Provide the following description of the torus interior corrosive environment and details of aging management of the torus shell: The torus shell is constructed of carbon steel and may have an uncoated interior shell. The interior of the torus is considered a potential moisture corrosive environment. The interior of the torus could be filled with nitrogen and is about half full with demineralized water. The exterior of the torus shell, including the support structures, base plates, anchor bolts, concrete support elements, and protective coatings, should be inspected every refueling outage for evidence of degradation. Aging management of the torus includes scheduled condition monitoring to periodically assess the thickness of the shell. Condition monitoring activities consist of UT thickness measurements at pre-selected, known minimum thickness areas of the shell. These measurements are repeated at the same locations on a regular basis. UT thickness measurements are also performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell, such as pitting corrosion. Material coupons representing the torus shell material, inserted inside the torus, are used in addition to the actual measurements, to determine the corrosion rate. The data is collected and compared to minimum wall thickness requirements. A conservative corrosion rate is developed and used to project the wall thickness at end of the period of extended operation.	Revise or update the program description.
a.2: (Ginna plant visit) *Federal Register*, Vol. 76, No. 119, Tuesday, June 21, 2011, states that: The NRC has evaluated Subsections IWB, IWC, IWD,	As stated in the *Federal Register*, Vol. 76, No. 119, Tuesday, June 21, 2011, Section XI of the ASME B&PV Code, Subsection IWE should be adopted in the AMP of	Revise or update the program

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IWE, IWF, and IWL of Section XI of the ASME B&PV Code, 2004 Edition with the 2005 and 2006 Addenda through the 2007 Edition with the 2008 Addenda as part of the § 50.55a amendment process to determine if the conclusions of the GALL Report also apply to AMPs that rely upon the ASME B&PV Code editions and addenda that are incorporated by reference into 50.55a by this rule. The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the report.	the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda.	description.
Program Basis Documents and/or Supporting Documents		
10 CFR 50.55a and ASME Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, Subsection IWE: • NRC IN 2010-12, “Containment Liner Corrosion.” • NRC IN 2011-15, “Steel Containment Degradation and Associated License Renewal Aging Management Issues.” Final License Renewal Interim Staff Guidance LR-ISG-2006-01: Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell.		
b.1: (NMP-1 plant audit) NRC issued IN 2011-15, “Steel Containment Degradation and Associated License Renewal Aging Management Issues” on the recent issues identified concerning degradation of steel containments that could impact aging management of containment structures during the period of extended operation. The IN describes the problems found in recent inspections of steel containments in the Cooper, Hope Creek, and Dresden plants. NRC issued IN 2010-12, “Containment Liner Corrosion” addressing corrosion of steel containment liners of Beaver	Expand and enhance the AMP based on information described in the recent NRC IN: • NRC IN 2010-12, “Containment Liner Corrosion.” • NRC IN 2011-15, “Steel Containment Degradation and Associated License Renewal Aging Management Issues.”	Revise or update the AMP program elements.

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Valley, Salem, and Brunswick plants. NRC Information Notice 97-10 addresses liner plate corrosion at Robinson plant. The operating experiences mentioned in the above NRC IN are not included in the GALL.		
b.2: (NMP-1 plant audit) LR-ISG-2006-01 is an important document. It contains comprehensive aging management for inaccessible areas of the BWR Mark I Steel Containment Drywell Shell.	Expand and enhance the AMP based on guidelines provided in LR-ISG-2006-01 and add LR-ISG-2006-01 to the references.	Revise the AMP program elements.
Program Consistency and Commitments		
NMP-1 has the following commitment in the SERF Appendix A prior to the PEO: an augmented VT-1 visual examination of the containment penetrations bellows will be performed using enhanced techniques qualified for detecting SCC, per NUREG-1611, Table 2, Item 12.		
c.1 NUREG-1611, Table 2 Item 12 states the following: Issue: NUREG-1557 indicates that SCC is insignificant for concrete containment steel liner, free-standing steel containment shells, and common steel components in the containment environment unless dissimilar metal is used, and in the case of SS bellows assemblies for CS vent lines or pipe sleeves if the materials are protected by shields from corrosive environment. (Page B-37 of NUREG-1557). Recommendation: This issue would be managed by Examination Categories E-B & E-F of Subsection IWE and Appendix J to 10 CFR 50. In addition, an augmented VT-1 visual examination of bellows bodies should be performed using enhanced techniques qualified for detecting stress corrosion cracking in bellows bodies.	Based on NUREG-1611, Table 2, Item 12, using an augmented VT-1 visual examination for detecting SCC in the bellows bodies should be recommended in the AMP.	Revise or update the AMP program element.
1. Scope of Program		

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The ASME Code Section XI, Subsection IWE, is a condition monitoring program. The program is augmented to include preventive actions that ensure that moisture levels associated with an accelerated corrosion rate do not exist in the exterior portion of the BWR Mark I steel containment drywell shell. The actions consist of ensuring that the sand pocket area drains and/or the refueling seal drains are clear. The program is also augmented to require that the selection of bolting material installation torque or tension and the use of lubricants and sealants are in accordance with the guidelines of EPRI NP-5769, EPRI TR-104213, and the additional recommendations of NUREG-1339 to prevent or mitigate degradation and failure of structural bolting. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and stress corrosion cracking potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication "Specification for Structural Joints Using ASTM A325 or A490 Bolts," need to be considered.		
1.1: (NMP-1 plant audit) There are two NRC INs issued after GALL 2 related to corrosion of the containment liner. The information in these INs needs to be addressed in the AMP.	Update and expand the scope of program based on NRC IN 2010-12, IN 2011-15, and LR-ISG-2006-01, as appropriate.	Revise the AMP program element.
2. Preventive Actions		
The ASME Code Section XI, Subsection IWE, is a condition monitoring program. The program is augmented to include preventive actions that ensure that moisture levels associated with an accelerated corrosion rate do not exist in the exterior portion of the BWR Mark I steel containment drywell shell. The actions consist of ensuring that the sand pocket area drains and/or the refueling seal drains are clear. The program is also augmented to require that the selection of bolting material installation torque or tension and the use of lubricants and sealants are in accordance with the guidelines of EPRI NP-5769, EPRI TR-104213, and the additional recommendations of NUREG-1339 to prevent or mitigate degradation and failure of structural bolting. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and stress corrosion cracking potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication "Specification for Structural Joints Using ASTM A325 or A490 Bolts," need to be considered.		
2.1: (NMP-1 plant audit) For Mark I steel containment, NMP-1 performs cleaning of the area coolers in a maintenance procedure that could prevent corrosion for the dry well shell near and underneath the coolers and sand pocket region. The GALL program element could involve cleaning of the area coolers during maintenance as a preventive action.	Include cleaning of the area coolers during maintenance procedures as a preventive action to prevent corrosion for the dry well shell near and underneath the coolers and sand pocket region.	Revise or update the AMP program element.
2.2: (NMP-1 plan audit) The torus shell of NMP-1 is not coated, and little margin is left on the wall thickness based	Add a coating to the inside of the torus shell as a preventive measure.	Revise the AMP program

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
on the NMP-1 audit report.		element.
3. Parameters Monitored/Inspected		
Table IWE-2500-1 references the applicable sections in IWE-2300 and IWE-3500 that identify the parameters examined or monitored. Non-coated surfaces are examined for evidence of cracking, discoloration, wear, pitting, excessive corrosion, arc strikes, gouges, surface discontinuities, dents, and other signs of surface irregularities. Painted or coated surfaces are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress. Stainless steel penetration sleeves, dissimilar metal welds, bellows, and steel components that are subject to cyclic loading but have no current licensing basis fatigue analysis are monitored for cracking. The moisture barriers are examined for wear, damage, erosion, tear, surface cracks, or other defects that permit intrusion of moisture in the inaccessible areas of the pressure retaining surfaces of the metal containment shell or liner. Pressure-retaining bolting is examined for loosening and material conditions that cause the bolted connection to affect either containment leak-tightness or structural integrity. As recommended in LR-ISG-2006-01, license renewal applicants with BWR Mark I steel containments should monitor the sand pocket area drains and/or the refueling seal drains for water leakage. The licensees should ensure the drains are clear to prevent moisture levels associated with accelerated corrosion rates in the exterior portion of the drywell shell.		
3.1: (NMP-1 plant audit) The GALL program element states that "Painted or coated surfaces are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress." The statement is unclear about whether examination of coating surfaces includes internal coatings of the torus shell that can be examined during plant outage.	Revise the statement as follows: Painted or coated surfaces (including paints inside the torus shell) are examined for evidence of flaking, blistering, peeling, discoloration, and other signs of distress.	Revise or update the AMP program element.
3.2: (NMP-1 plant audit) The GALL program element does not provide guidance on parameters monitored/inspected for the torus shell. NMP-1 specifies that for the torus shell, parameters monitored and inspected include the following: (a) shell thickness, (b) degraded external shell coatings and support structure coatings, and (c) degraded torus support structure elements (i.e., tie rods, anchor bolts, base plates, welds).	Add parameters monitored/inspected for the torus shell, including shell thickness, internal and external shell coatings, support structure coatings and torus support structure elements (i.e., tie rods, anchor bolts, base plates, welds).	Revise or update the AMP program element.
4. Detection of Aging Effects		

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The examination methods, frequency, and scope of examination specified in 10 CFR 50.55a and Subsection IWE ensure that aging effects are detected before they compromise the design-basis requirements. IWE-2500-1 and the requirements of 10 CFR 50.55a provide information regarding the examination categories, parts examined, and examination methods to be used to detect aging. As indicated in IWE-2400, inservice examinations are performed in accordance with one of two inspection programs, A or B, on a specified schedule. Under Inspection Program A, there are four inspection intervals (at 3, 10, 23, and 40 years) for which 100% of the required examinations must be completed. Within each interval, there are various inspection periods for which a certain percentage of the examinations are to be performed to reach 100% at the end of that interval. After 40 years of operation, any future examinations are performed in accordance with Inspection Program B. Under Inspection Program B, starting with the time the plant is placed into service, there is an initial inspection interval of 10 years and successive inspection intervals of 10 years each, during which 100% of the required examinations are to be completed. An expedited examination of containment is required by 10 CFR 50.55a, in which an inservice (baseline) examination specified for the first period of the first inspection interval for containment was to be performed by September 9, 2001. Thereafter, subsequent examinations are performed every 10 years from the baseline examination. Regarding the extent of examination, all accessible surfaces receive a visual examination as specified in Table IWE-2500-1 and the requirements of 10 CFR 50.55a. The acceptability of inaccessible areas of the BWR Mark I steel containment drywell is evaluated when conditions exist in the adjacent accessible areas that could indicate the presence of moisture or could result in degradation to such inaccessible areas. IWE-1240 requires augmented examinations (Examination Category E-C) of containment surface areas subject to degradation. A VT-1 visual examination is performed for areas accessible from both sides, and volumetric (ultrasonic thickness measurement) examination is performed for areas accessible from only one side. The requirements of ASME Section XI, Subsection IWE and 10 CFR 50.55a are augmented to require surface examination, in addition to visual examination, to detect cracking in stainless steel penetration sleeves, dissimilar metal welds, bellows, and steel components that are subject to cyclic loading but have no current licensing basis fatigue analysis. Where feasible, Appendix J tests (AMP XI.S4) may be performed in lieu of the surface examination.		
4.1: (NMP-1 plant audit) The whole containment surface was photographed in NMP-1 as a baseline before entering the PEO. This is a good practice and should be implemented as a generic good practice for all plants.	Taking photographs of whole containment surfaces as a baseline before entering the PEO would help identify aging effects in later inspections. This is a good practice and should be recommended in the program element.	Revise or update the AMP program element.
4.2: (NMP-1 plan audit) The torus shell of NMP-1 is not coated, and little margin is left on the wall thickness based on the NMP-1 audit report. The shell wall close to the water-air interface line inside the torus shell is more	Add inspections of the inside of the torus during outages and focus on the areas close to the water-air interface line.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
susceptible to corrosion.		
5. Monitoring and Trending		
With the exception of inaccessible areas, all surfaces are monitored by virtue of the examination requirements on a scheduled basis. IWE-2420 specifies that: (a) The sequence of component examinations established during the first inspection interval shall be repeated. (b) When examination results require evaluation of flaws or areas of degradation in accordance with IWE-3000, and the component is acceptable for continued service, the areas containing such flaws or areas of degradation shall be reexamined during the next inspection period listed in the schedule of the inspection program of IWE-2411 or IWE-2412, in accordance with Table IWE-2500-1, Examination Category E-C. (c) When the reexaminations required by IWE-2420(b) reveal that the flaws or areas of degradation remain essentially unchanged for the next inspection period, these areas no longer require augmented examination in accordance with Table IWE-2500-1 and the regular inspection schedule is continued. Applicants for license renewal for plants with BWR Mark I containment should augment IWE monitoring and trending requirements to address inaccessible areas of the drywell. The applicant should consider the following recommended actions based on plant-specific operating experience. (a) Develop a corrosion rate that can be inferred from past ultrasonic testing (UT) examinations or establish a corrosion rate using representative samples in similar operating conditions, materials, and environments. If degradation has occurred, provide a technical basis using the developed or established corrosion rate to demonstrate that the drywell shell will have sufficient wall thickness to perform its intended function through the period of extended operation. (b) Demonstrate that UT measurements performed in response to U.S. Nuclear Regulatory Commission (NRC) Generic Letter (GL) 87-05 did not show degradation inconsistent with the developed or established corrosion rate.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
IWE-3000 provides acceptance standards for components of steel containments and liners of concrete containments. IWE-3410 refers to criteria to evaluate the acceptability of the containment components for service following the preservice examination and each inservice examination. Most of the acceptance standards rely on visual examinations. Areas that are suspect require an engineering evaluation or require correction by repair or replacement. For some examinations, such as augmented examinations, numerical values are specified for the acceptance standards. For the containment steel shell or liner, material loss locally exceeding 10% of the nominal containment wall thickness or material loss that is projected to locally exceed 10% of the nominal containment wall thickness before the next examination		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
are documented. Such areas are corrected by repair or replacement in accordance with IWE-3122 or accepted by engineering evaluation. Cracking of stainless steel penetration sleeves, dissimilar metal welds, bellows, and steel components that are subject to cyclic loading but have no current licensing basis fatigue analysis is corrected by repair or replacement or accepted by engineering evaluation.		
6.1: (NMP-1 plant audit) The GALL does not provide guidance on acceptance criteria of Mark I steel containment. The acceptance criteria of NMP-1 steel containment consists of the following: For Mark I steel containment, the projected wall thickness at the end of the PEO should be greater than the minimum design wall thickness. The wall thickness and corrosion rate (mils/year) should be periodically measured in accordance to IWE requirements. Torus shell thickness should not be less than the required thickness through the PEO. Acceptance criteria of local wall thickness and average wall thickness, and conservative corrosion rate should be established. The minimum wall thickness and corrosion rate limits should be defined to ensure that the minimum wall thickness requirement would not be violated before the next scheduled inspection.	Incorporate the acceptance criteria used in NMP-1 as guidance for Mark I steel containment.	Revise the AMP program element.
7. Corrective Actions		
Subsection IWE states that components whose examination results indicate flaws or areas of degradation that do not meet the acceptance standards listed in IWE-3500 are acceptable if an engineering evaluation indicates that the flaw or area of degradation is nonstructural in nature or has no effect on the structural integrity of the containment. Components that do not meet the acceptance standards are subject to additional examination requirements, and the components are repaired or replaced to the extent necessary to meet the acceptance standards of IWE-3000. For repair of components within the scope of Subsection IWE, IWE-3124 states that repairs and reexaminations are to comply with IWA-4000. IWA-4000 provides repair specifications for pressure retaining components, including metal containments and metallic liners of concrete containments. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions. If moisture has been detected or suspected in the inaccessible area on the exterior of the Mark I containment drywell shell or the source of moisture cannot be determined subsequent to root cause analysis, then:		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
(a) Include in the scope of license renewal any components that are identified as a source of moisture, if applicable, such as the refueling seal or cracks in the stainless liners of the refueling cavity pools walls, and perform aging management review. (b) Identify surfaces requiring examination by implementing augmented inspections for the period of extended operation in accordance with Subsection IWE-1240, as identified in Table IWE-2500-1, Examination Category E-C. (c) Use examination methods that are in accordance with Subsection IWE-2500. (d) Demonstrate, through use of augmented inspections performed in accordance with Subsection IWE, that corrosion is not occurring or that corrosion is progressing so slowly that the age-related degradation will not jeopardize the intended function of the drywell shell through the period of extended operation.		
7.1: No further review item was identified.		
8. Confirmation Process		
When areas of degradation are identified, an evaluation is performed to determine whether repair or replacement is necessary. If the evaluation determines that repair or replacement is necessary, Subsection IWE specifies confirmation that appropriate corrective actions have been completed and is effective. Subsection IWE states that repairs and reexaminations are to comply with the requirements of IWA-4000. Reexaminations are conducted in accordance with the requirements of IWA-2200, and the recorded results are to demonstrate that the repair meets the acceptance standards set forth in IWE-3500. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
IWA-6000 provides specifications for the preparation, submittal, and retention of records and reports. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
ASME Section XI, Subsection IWE, was incorporated into 10 CFR 50.55a in 1996. Prior to this time, operating experience pertaining to degradation of steel components of containment was gained through the inspections required by 10 CFR Part 50, Appendix J and ad hoc inspections conducted by licensees and the NRC. NRC Information Notice (IN) 86-99, IN 88-82, IN 89-79, IN 2004-09, and NUREG-1522 described occurrences of corrosion in steel containment shells. NRC GL 87-05 addressed the potential for corrosion of BWR Mark I steel drywells in the “sand pocket region.” NRC IN 97-10 identified specific locations where concrete containments are susceptible to liner plate corrosion; IN 92-20 described an instance of containment bellows cracking, resulting in loss of leak tightness. More recently, IN 2006-01 described a through-wall cracking and its probable cause in the torus of a BWR Mark I containment. The cracking was identified by the licensee in the heat-affected zone at		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
the high pressure cooling injection (HPCI) turbine exhaust pipe torus penetration. The licensee concluded that the cracking was most likely initiated by cyclic loading due to condensation oscillation during HPCI operation. These condensation oscillations induced on the torus shell may have been excessive due to a lack of an HPCI turbine exhaust pipe sparger that many licensees have installed. Other operating experience indicates that foreign objects embedded in concrete have caused through-wall corrosion of the liner plate at a few plants with reinforced concrete containments. The program is to consider the liner plate and containment shell corrosion and cracking concerns described in these generic communications. Implementation of the ISI requirements of Subsection IWE, in accordance with 10 CFR 50.55a, augmented to consider operating experience, and as recommended in LR-ISG-2006-01, is a necessary element of aging management for steel components of steel and concrete containments through the period of extended operation. Degradation of threaded bolting and fasteners in closures for the reactor coolant pressure boundary has occurred from boric acid corrosion, stress corrosion cracking (SCC), and fatigue loading (NRC IE Bulletin 82-02, NRC GL 91-17). SCC has occurred in high strength bolts used for nuclear steam supply system component supports (EPRI NP-5769). The augmented ASME Section XI, Subsection IWE, incorporating recommendations documented in EPRI NP-5769 and TR-104213, is necessary to ensure containment bolting integrity.		
10.1: (NMP-1 plant audit) NRC issued IN 2011-15, "Steel Containment Degradation and Associated License Renewal Aging Management Issues" on the recent issues identified concerning degradation of steel containments that could impact aging management of containment structures during the period of extended operation. The IN describes the problems found in recent inspections of steel containments in the Cooper, Hope Creek, and Dresden plants. NRC issued IN 2010-12, "Containment Liner Corrosion," addressing corrosion of steel containment liners in the Beaver Valley, Salem, and Brunswick plants. NRC Information Notice 97-10 addresses liner plate corrosion at the Robinson plant. The operating experience mentioned in the above NRC INs is not included in the GALL.	The operating experience described in the following NRC IN should be included: • NRC Information Notice 97-10; • NRC IN 2010-12, "Containment Liner Corrosion"; and • NRC IN 2011-15, "Steel Containment Degradation and Associated License Renewal Aging Management Issues."	Revise or update the AMP program element.
10.2: (NMP-1 plant audit) The GALL program element states that "NRC GL 87-05 addressed the potential for corrosion of BWR Mark I steel drywells in the 'sand pocket	The following statement should be added: "NRC GL 87-05 addressed the potential for corrosion and <u>needs for inspection</u> of BWR Mark I steel drywells in the 'sand pocket	Revise the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
region.'"	region.'"	
10.3: (NMP-1 plant audit) The GALL program element states that "These condensation oscillations induced on the torus shell may have been excessive due to a lack of an HPCI turbine exhaust pipe sparger that many licensees have installed."	The following statement should be added: "These condensation oscillations induced on the torus shell may have been excessive due to a lack of an HPCI turbine exhaust pipe sparger that many licensees have installed. Dry well liner also experienced major rust under area coolers."	Revise or update the AMP program element.
10.4: (NMP-1 plant audit) The GALL program element states that "Other operating experience indicates that foreign objects embedded in concrete have caused through-wall corrosion of the liner plate at a few plants with reinforced concrete containments."	The following statement should be added: "Other operating experience indicates that foreign objects embedded in concrete have caused through-wall corrosion of the liner plate at a few plants with reinforced concrete containments. Through-wall cracking was detected in torus. Cracking was repaired by welding a plate on the outside of the shell."	Revise or update the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR Part 50, Appendix J, *Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWA, *General Requirements,* The ASME Boiler and Pressure Vessel Code, 2004 edition as incorporated by reference in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components, Subsection IWB, Requirements for Class 1 Components of Light-Water Cooled Power Plants*, The ASME Boiler and Pressure Vessel Code, 2004 edition as incorporated by reference in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWC, *Requirements for Class 2 Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWE, *Requirements for Class MC and Metallic Liners of Class CC Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as incorporated by reference in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWL, *Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as incorporated by reference in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volumes 1 and 2, Electric Power Research Institute, April 1988.

EPRI NP-5067, *Good Bolting Practices, A Reference Manual for Nuclear Power Plant Maintenance Personnel*, Volume 1: Large Bolt Manual, 1987; Volume 2: Small Bolts and Threaded Fasteners, Electric Power Research Institute, 1990.

EPRI TR-104213, *Bolted Joint Maintenance & Application Guide,* Electric Power Research Institute, December 1995.

RCSC (Research Council on Structural Connections): *Specification for Structural Joints Using ASTM A325 or A490 Bolts,* 2004.

NRC Inspection and Enforcement Bulletin No. 82-02, *Degradation of Threaded Fasteners in the Reactor Coolant Pressure Boundary of PWR Plants*, U.S. Nuclear Regulatory Commission, June 2, 1982.

NRC Generic Letter 87-05, *Request for Additional Information Assessment of Licensee Measures to Mitigate and/or Identify Potential Degradation of Mark I Drywells,* U.S. Nuclear Regulatory Commission, March 12, 1987.

NRC Generic Letter 91-17, *Generic Safety Issue 29, Bolting Degradation or Failure in Nuclear Power Plants,* U.S. Nuclear Regulatory Commission, October 17, 1991.

NRC Information Notice 86-99, *Degradation of Steel Containments,* U.S. Nuclear Regulatory Commission, December 8, 1986 and Supplement 1, February 14, 1991.

NRC Information Notice 88-82, *Torus Shells with Corrosion and Degraded Coatings in BWR Containments,* U.S. Nuclear Regulatory Commission, October 14, 1988 and Supplement 1, May 2, 1989.

NRC Information Notice 89-79, *Degraded Coatings and Corrosion of Steel Containment Vessels,* U.S. Nuclear Regulatory Commission, December 1, 1989 and Supplement 1, June 29, 1989.

NRC Information Notice 92-20, *Inadequate Local Leak Rate Testing,* U.S. Nuclear Regulatory Commission, March 3, 1992.

NRC Information Notice 97-10, *Liner Plate Corrosion in Concrete Containment,* U.S. Nuclear Regulatory Commission, March 13, 1997.

NRC Information Notice 2004-09, *Corrosion of Steel Containment and Containment Liner*, U.S. Nuclear Regulatory Commission, April 27, 2004.

NRC Information Notice 2006-01, *Torus Cracking in a BWR Mark I Containment*, U.S. Nuclear Regulatory Commission, January 12, 2006.

NRC Morning Report, *Failure of Safety/Relief Valve Tee-Quencher Support Bolts*, March 14, 2005. (ADAMS Accession Number ML050730347)

NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, June 1990.

NUREG-1522, *Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures*, June 1995.

Staff Position and Rationale for the Final License Renewal Interim Staff Guidance LR-ISG-2006-01, *Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor (BWR) Mark I Steel Containments Drywell Shell,* Nuclear Regulatory Commission, November 16, 2006.

Additional References

NRC LR-ISG-2006-01, *Plant-Specific Aging Management Program for Inaccessible Areas of Boiling Water Reactor Mark I Steel Containment Drywell Shell*, (ML063210041), U.S. Nuclear Regulatory Commission, Washington, DC, 2006.

NRC Information Notice 2010-12, *Containment Liner Corrosion,* U.S. Nuclear Regulatory Commission, Washington, DC, June 18, 2010.

NRC Information Notice 2011-15, *Steel Containment Degradation and Associated License Renewal Aging Management Issues,* U.S. Nuclear Regulatory Commission, Washington, DC, August 1, 2011

A.41 XI.S2 ASME Section XI, Subsection IWL

The verbatim text of GALL, Rev. 2, AMP XI.S2, ASME Section XI, Subsection IWL, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
10 CFR 50.55a imposes the examination requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, Subsection IWL, for reinforced and prestressed concrete containments (Class CC). The scope of IWL includes reinforced concrete and unbonded post-tensioning systems. This evaluation covers the 2004 edition of the ASME Code, Section XI, as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWL and the additional requirements specified in 10 CFR 50.55a(b)(2) constitute an existing mandated program applicable to managing aging of containment reinforced concrete and unbonded post-tensioning systems for license renewal. The primary inspection method specified in IWL-2500 is visual examination, supplemented by testing. For prestressed containments, tendon wires are tested for yield strength, ultimate tensile strength, and elongation. Tendon corrosion protection medium is analyzed for alkalinity, water content, and soluble ion concentrations. The quantity of free water contained in the anchorage end cap and any free water that drains from tendons during the examination is documented. Samples of free water are analyzed for pH. Prestressing forces are measured in selected sample tendons. IWL specifies acceptance criteria, corrective actions, and expansion of the inspection scope when degradation exceeding the acceptance criteria is found. The 2004 edition of the Code specifies augmented examination requirements following post-tensioning system repair/replacement activities. The post-tensioning system repair/replacement activities are to be in accordance with the requirements of the 2004 edition of the Code.		
a.1: (Ginna plant visit) In the Ginna plant, hot penetrations in containments were designed with a forced air cooling system connected to cooling coils integrated with the penetration sleeves. The cooling air exit temperature is monitored and can be related to the concrete-to-sleeve interface temperature. The penetration cooling system is within the scope of license renewal and is included in the aging management review for the essential ventilation	The GALL report does not include aging management of the cooling systems that control concrete temperatures. Concrete cooling systems should be included in the AMP.	Revise or update the program description.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
system. The primary shield wall concrete is also subject to extended local heatup at Ginna Station. The purpose of the reactor compartment cooling system is to remove the heat generated by gamma rays in the primary shield and the thermal radiation from the reactor vessel and out-of-core detectors electrical load. Removal of this heat maintains the concrete temperature in the primary shield walls below degradation threshold and localized temperature limits of American Concrete Institute (ACI) standards (i.e., 150°F). The reactor compartment cooling is also within the scope of license renewal and is included in the aging management review for the containment ventilation system.		
a.2: (NMP-1 plant audit) Groundwater penetration/leakage occurs frequently in the plants. It could become a severe problem as plants get older. Examples of recent operating experience with groundwater penetration/leakage include the following: 1. Reactor cavity water leakage of 3–10 gallons/minute or 4000–10,000 gallons/day since 1999. (Staff audit report on Ginna Structures Monitoring AMP). 2. A NRC 2011 inspection report revealed that groundwater penetration to an underground electric tunnel at the Seabrook plant caused concrete to lose more than 20 percent of its strength. The degradation is due to sulfate attack when concrete is saturated in water. 3. NMP-1 Plant Operating Experience: (SER 3.0.3.2.21): - minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels; - Several CRs have identified minor cracking in concrete structures including the service water pipe tunnel, which is susceptible to small wall cracks that allow leakage of groundwater; and	Aging management should be addressed in dealing with groundwater penetration/leakage, and guidelines should be provided using the lessons learned from Seabrook and other operating experience. Aging management of structures due to groundwater penetration/leakage would be an important task in the program.	Update or revise the program description to include management of groundwater leakage.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
- groundwater has entered the switchgear building, service water tunnels, and the radwaste building below grade exterior walls. These operating experiences indicate that the AMP may need to be enhanced when dealing with groundwater penetration/leakage.		
a.3: (Ginna plant visit) *Federal Register* Vol. 76, No. 119, Tuesday, June 21, 2011, states that: The NRC has evaluated Subsections IWB, IWC, IWD, IWE, IWF, and IWL of Section XI of the ASME B&PV Code, 2004 Edition, with 2005 and 2006 Addenda, through the 2007 Edition with 2008 Addenda as part of the §50.55a amendment process to determine if the conclusions of the GALL Report also apply to AMPs that rely upon the ASME B&PV Code editions and addenda that are incorporated by reference into 50.55a by this rule. The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.	As stated in the Federal Register Vol. 76, No. 119, June 21, this AMP should adopt ASME B&PV Code Section XI, Subsections IWL, 2004 edition inclusive of 2005 and 2006 addenda, and the 2007 edition inclusive of the 2008 addenda.	Revise or update the program description.
Program Basis Documents and/or Supporting Documents		
10 CFR 50.55a (the Maintenance Rule) and ASME Section XI IWL Inservice Inspection		
b.1: No further review item was identified.		
Program Consistency and Commitments		
The AMP for both Ginna and NMP-1 plants is consistent with GALL, Rev. 0, AMP XI.S2 ASME Section XI, Subsection IWL, and there are		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
no Commitments in the SER for this program.		
c.1: No further review item was identified.		
1. Scope of Program		
Subsection IWL-1000 specifies the components of concrete containments within its scope. The components within the scope of Subsection IWL are reinforced concrete and unbonded post-tensioning systems of Class CC containments, as defined by CC-1000. The program also includes testing of the tendon corrosion protection medium and the pH of free water. Subsection IWL exempts from examination portions of the concrete containment that are inaccessible (e.g., concrete covered by liner, foundation material, or backfill or obstructed by adjacent structures or other components). 10 CFR 50.55a(b)(2)(viii) specifies additional requirements for inaccessible areas. It states that the licensee is to evaluate the acceptability of concrete in inaccessible areas when conditions exist in accessible areas that could indicate the presence of or result in degradation to such inaccessible areas. Steel liners for concrete containments and their integral attachments are not within the scope of Subsection IWL but are included within the scope of Subsection IWE. Subsection IWE is evaluated in AMP XI.S1.		
1.1: (Ginna plant visit) Same as a.1.	Include concrete cooling systems in the AMP.	Revise scope of program.
1.2: (NMP-1 plant visit) Same as a.2.	Address aging management in dealing with groundwater penetration/leakage and provide guidelines using the lessons learned from the Seabrook plant and other operating experience. Aging management of structures due to groundwater penetration/leakage would be an important task in this program.	Revise or update the AMP program element.
2. Preventive Actions		
ASME Code Section XI, Subsection IWL is a condition monitoring program. However, the program includes actions to prevent or minimize corrosion of the prestressing tendons by maintaining corrosion protection medium chemistry within acceptable limits specified in IWL.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
Table IWL-2500-1 specifies two categories for examination of concrete surfaces: Category L-A for all accessible concrete surfaces and Category L-B for concrete surfaces surrounding anchorages of tendons selected for testing in accordance with IWL-2521. Both of these categories rely on visual examination methods. Concrete surfaces are examined for evidence of damage or degradation, such as concrete		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
cracks. IWL-2510 specifies that concrete surfaces are examined for conditions indicative of degradation, such as those defined in ACI 201.1R and ACI 349.3R. Table IWL-2500-1 also specifies Category L-B for test and examination requirements for unbonded post tensioning systems. The number of tendons selected for examination is in accordance with Table IWL-2521-1. Additional augmented examination requirements for post-tensioning system repair/replacement activities are to be in accordance with Table IWL-2521-2. Tendon anchorage and wires or strands are visually examined for cracks, corrosion, and mechanical damage. Tendon wires or strands are also tested for yield strength, ultimate tensile strength, and elongation. The tendon corrosion protection medium is tested by analysis for alkalinity, water content, and soluble ion concentrations. The pH of free water samples is analyzed.		
3.1: (Ginna plant audit) The licensee photographed the whole of the containment surface as a baseline record prior to the PEO in 2002–2003. This is commendable and should be implemented at other plants.	Photograph the whole of the containment surface as a baseline record prior to the PEO.	Revise or update the AMP program element.
4. Detection of Aging Effects		
The frequency and scope of examinations specified in 10 CFR 50.55a and Subsection IWL ensure that aging effects would be detected before they would compromise the design-basis requirements. The frequency of inspection is specified in IWL-2400. Concrete inspections are performed in accordance with Examination Category L-A. Under Subsection IWL, inservice inspections of concrete and unbonded post-tensioning systems are required at 1, 3, and 5 years following the initial structural integrity test. Thereafter, inspections are performed at 5-year intervals. For sites with multiple plants, the schedule for inservice inspection is provided in IWL-2421. In the case of tendons, only a sample of the tendons of each tendon type requires examination during each inspection. The tendons to be examined during an inspection are selected on a random basis. Regarding detection methods for aging effects, all accessible concrete surfaces receive General Visual examination (as defined by the ASME Code). Selected areas, such as those that indicate suspect conditions and concrete surface areas surrounding tendon anchorages (Category L-B), receive a more rigorous Detailed Visual examination (as defined by the ASME Code). Prestressing forces in sample tendons are measured. In addition, one sample tendon of each type is detensioned. A single wire or strand is removed from each detensioned tendon for examination and testing. These visual examination methods and testing would identify the aging effects of accessible concrete components and prestressing systems in concrete containments. Examination of corrosion protection medium and free water are tested for each examined tendon as specified in Table IWL-2525-1.		
4.1: Review of the topical report NUREG/CR-6927 “Primer on Durability of Nuclear Power Plant Reinforced Concrete Structures - A Review of Pertinent Factors” Feb. 2007 (Naus) indicates that a potential aging degradation mechanism, called delayed ettringite formation (DEF), may occur for the concrete structures during the subsequent	Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate-to-aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment (NUREG/CR-6927, Naus).	Update or revise the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
renewal. This degradation is caused by excessive heat curing that decomposes the ettringite in Portland cement during the hydration process. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, and the destructive expansive forces crack the concrete. DEF was first reported in heat-cured railway ties in Germany in the early 1980s. Since then, several other countries, including the United States, have reported DEF problems in concrete structures (DOT News Letter, July 2004). The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev.2, related to concrete structures.	The aging effects/mechanism due to DEF and the preventive measurements are recommended to be included in the AMPs.	
5. Monitoring and Trending		
Except in inaccessible areas, all concrete surfaces are monitored on a regular basis by virtue of the examination requirements. For prestressed containments, trending of prestressing forces in tendons is required in accordance with paragraph (b)(2)(viii) of 10 CFR 50.55a. In addition to the random sampling used for tendon examination, one tendon of each type is selected from the first-year inspection sample and designated as a common tendon. Each common tendon is then examined during each inspection. Corrosion protection medium chemistry and free water pH are monitored for each examined tendon. This procedure provides monitoring and trending information over the life of the plant. 10 CFR 50.55a and Subsection IWL also require that prestressing forces in all inspection sample tendons be measured by lift-off tests and compared with acceptance standards based on the predicted force for that type of tendon over its life.		
5.1: (NMP-1 plant audit) NMP-1 appears have no trending report on a regular basis. It is important to stress the importance of performing trending in a regular basis.	Change the program element name from “Monitoring and Trending” to “Trending” to emphasize the importance of trending on a regular basis (e.g., providing a trending report on a 6-month basis).	Update the AMP program element.
6. Acceptance Criteria		
IWL-3000 provides acceptance criteria for concrete containments. For concrete surfaces, the acceptance criteria rely on the determination of the "Responsible Engineer" (as defined by the ASME Code) regarding whether there is any evidence of damage or degradation sufficient to warrant further evaluation or repair. The acceptance criteria are qualitative; guidance is provided in IWL-2510, which references ACI 201.1R and ACI 349.3R for identification of concrete degradation. IWL-2320 requires that the Responsible Engineer be a		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
registered professional engineer experienced in evaluating the inservice condition of structural concrete and knowledgeable of the design and construction codes and other criteria used in design and construction of concrete containments. Quantitative acceptance criteria based on the "Evaluation Criteria" provided in Chapter 5 of ACI 349.3R also may be used to augment the qualitative assessment of the Responsible Engineer. The acceptance standards for the unbonded post-tensioning system are quantitative in nature. For the post-tensioning system, quantitative acceptance criteria are given for tendon force and elongation, tendon wire or strand samples, and corrosion protection medium. Free water in the tendon anchorage areas is not acceptable, as specified in IWL-3221.3. If free water is found, the recommendations in Table IWL-2525-1 are followed. 10 CFR 50.55a and Subsection IWL do not define the method for calculating predicted tendon prestressing forces for comparison to the measured tendon lift-off forces. The predicted tendon forces are calculated in accordance with Regulatory Guide 1.35.1, which provides an acceptable methodology for use through the period of extended operation.		
6.1: No further review item was identified.		
7. Corrective Actions		
Subsection IWL specifies that items for which examination results do not meet the acceptance standards are to be evaluated in accordance with IWL-3300, "Evaluation," and described in an engineering evaluation report. The report is to include an evaluation of whether the concrete containment is acceptable without repair of the item and, if repair is required, the extent, method, and completion date of the repair or replacement. The report also identifies the cause of the condition and the extent, nature, and frequency of additional examinations. Subsection IWL also provides repair procedures to follow in IWL-4000. This includes requirements for the concrete repair, repair of reinforcing steel, and repair of the post-tensioning system. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
IWA-1400 specifies the preparation of plans, schedules, and inservice inspection summary reports. In addition, written examination instructions and procedures, verification of qualification level of personnel who perform the examinations, and documentation of a quality assurance program are specified. IWA-6000 specifically covers the preparation, submittal, and retention of records and reports. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
9.1: No further review item was identified.		
10. Operating Experience		
ASME Section XI, Subsection IWL was incorporated into 10 CFR 50.55a in 1996. Prior to this time, the prestressing tendon inspections were performed in accordance with the guidance provided in Regulatory Guide 1.35. Operating experience pertaining to degradation of reinforced concrete in concrete containments was gained through the inspections required by 10 CFR Part 50, Appendix J, and ad hoc inspections conducted by licensees and the Nuclear Regulatory Commission (NRC). NUREG-1522 described instances of cracked, spalled, and degraded concrete for reinforced and prestressed concrete containments. The NUREG also described cracked anchor heads for the prestressing tendons at three prestressed concrete containments. NRC Information Notice 99-10 described occurrences of degradation in prestressing systems. The program is to consider the degradation concerns described in these generic communications. Implementation of Subsection IWL, in accordance with 10 CFR 50.55a, is a necessary element of aging management for concrete containments through the period of extended operation.		
10.1: The program element does not contain information in recent NRC IN related containment degradation.	Include OE in recent NRC INs. 1. NRC IN 2010-14, Containment Concrete Surface Condition Examination Frequency and Acceptance. 2. NRC IN 99-10, Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments.	Update the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR Part 50, Appendix J, *Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ACI Standard 201.1R, *Guide for Making a Condition Survey of Concrete in Service,* American Concrete Institute.

ACI Standard 349.3R, *Evaluation of Existing Nuclear Safety-Related Concrete Structures,* American Concrete Institute, 2002.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWA, *General Requirements,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWE, *Requirements for Class MC and Metallic Liners of Class CC Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWL, *Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

NRC Information Notice 99-10, Revision 1, *Degradation of Prestressing Tendon Systems in Prestressed Concrete Containment,* U.S. Nuclear Regulatory Commission, October 7, 1999.

NRC Regulatory Guide 1.35.1, *Determining Prestressing Forces for Inspection of Prestressed Concrete Containments*, U.S. Nuclear Regulatory Commission, July 1990.

NRC Regulatory Guide 1.35, *Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containments,* U.S. Nuclear Regulatory Commission, July 1990

NUREG-1522, *Assessment of Inservice Condition of Safety-Related Nuclear Power Plant Structures,* June 1995.

Additional Reference

NRC Information Notice 2010-14 “Containment Concrete Surface Condition Examination Frequency And Acceptance Criteria,” U.S. Nuclear Regulatory Commission, Washington, DC, August 4, 2010.

A.42 XI.S3 ASME Section XI, Subsection IWF

The verbatim text of GALL, Rev. 2, AMP XI.S3, ASME Section XI, Subsection IWF, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
10 CFR 50.55a imposes the inservice inspection requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, for Class 1, 2, 3, and metal containment (MC) piping and components and their associated supports. Inservice inspection of supports for ASME piping and components is addressed in Section XI, Subsection IWF. This evaluation covers the 2004 edition of the ASME Code as approved in 10 CFR 50.55a. ASME Code, Section XI, Subsection IWF, constitutes an existing mandated program applicable to managing aging of ASME Class 1, 2, 3, and MC component supports for license renewal. The IWF scope of inspection for supports is based on sampling of the total support population. The sample size varies depending on the ASME Class. The largest sample size is specified for the most critical supports (ASME Class 1). The sample size decreases for the less critical supports (ASME Class 2 and 3). Discovery of support deficiencies during regularly scheduled inspections triggers an increase of the inspection scope in order to ensure that the full extent of deficiencies is identified. The primary inspection method employed is visual examination. Degradation that potentially compromises support function or load capacity is identified for evaluation. IWF specifies acceptance criteria and corrective actions. Supports requiring corrective actions are re-examined during the next inspection period. The requirements of subsection IWF are augmented to include monitoring of high-strength structural bolting (actual measured yield strength greater than or equal to 150 ksi or 1,034 MPa) for cracking. The program is augmented to incorporate recommendations delineated in NUREG-1339 and industry recommendations delineated in the Electric Power Research Institute (EPRI) NP-5769, NP-5067, and TR-104213 for high-strength structural bolting, if applicable. These recommendations emphasize proper selection of bolting material, lubricants, and installation torque or tension to prevent or minimize loss of bolting preload and cracking of high-strength bolting.		
a.1: (Ginna plant visit) The GALL, Rev. 2, is augmented to include monitoring of high-strength structural bolting based on NUREG-1339 and industry recommendations. Ginna's IWF AMP is based on GALL, Rev. 0, and monitoring of high-strength bolting is not included in the program basis document.	High-strength bolting may experience SCC and should be included in the program. The program description of the GALL may add the following statement to reflect the need: "For AMP programs developed based on previous GALL versions, the licensee may require updates to include monitoring of the high-	Revise the program description to reflect the need to include monitoring

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The licensee should update program basis documents to reflect changes in later versions of GALL (this is a generic implementation issue).	strength bolting in the AMP."	high-strength bolting.
a.2: (Ginna plant visit) *Federal Register*, Vol. 76, No. 119, Tuesday, June 21, 2011, states that: The NRC has evaluated Subsections IWB, IWC, IWD, IWE, IWF, and IWL of Section XI of the ASME B&PV Code, 2004 Edition with the 2005 and 2006 Addenda through the 2007 Edition with the 2008 Addenda as part of the §50.55a amendment process to determine if the conclusions of the GALL Report also apply to AMPs that rely upon the ASME B&PV Code editions and addenda that are incorporated by reference into §50.55a by this rule. The NRC finds that the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsections IWB, IWC, IWD, IWE, IWF, and IWL, as subject to the conditions of this rule, are acceptable to be adopted as AMPs for license renewal and the conclusions of the GALL Report remain valid, except where specifically noted and augmented in the GALL Report.	Adopt in the AMP of the 2004 Edition, inclusive of the 2005 and 2006 Addenda, and the 2007 Edition, inclusive of the 2008 Addenda of Section XI of the ASME B&PV Code, Subsection IWF, as stated in the *Federal Register*, Vol. 76, No. 119, Tuesday, June 21.	Revise or update the program description.
Program Basis Documents and/or Supporting Documents		
10 CFR 50.55a and ASME Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, Subsection IWF.		
b.1: No further review item was identified.		
Program Consistency and Commitments		
The AMP for both the Ginna and the NMP-1 plants <u>is consistent</u> with <u>GALL, Rev. 0,</u> AMP XI.S3, IWF Inservice Inspection, and there are no commitments in the SER for this program.		
c.1: No further review item was identified.		
1. Scope of Program		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
This program addresses supports for ASME Class 1, 2, and 3 piping and components supports that are not exempt from examination in accordance with IWF -1230 and MC supports. The scope of the program includes support members, structural bolting, high strength structural bolting, support anchorage to the building structure, accessible sliding surfaces, constant and variable load spring hangers, guides, stops, & vibration isolation elements.		
1.1: (NMP-1 plant audit) The NMP-1 IWF AMP does not include inaccessible piping supports because the GALL IWF AMP only recommends inspection of piping and components supports that are not exempt from IWF -1230 and MC supports. Exemptions are as stated in IWB-1220 including portions of supports that are inaccessible because of they are encased in concrete, buried underground, or encapsulated by guard pipe. The inaccessible components, such as embedded containment components, are included in the GALL XI.S2. IWE AMP scope of program by the statement that the licensee is to 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.	The GALL IWF should include the inaccessible items exempted from IWB-1220 in the scope of program to be consistent with IWE. These inaccessible items, according to IWB-1220, includes portions of supports that are inaccessible because they are encased in concrete, buried underground, or encapsulated by guard pipe. The following statement should be added to the scope of program: "10 CFR 50.55a(b)(2)(ix) specifies additional requirements for inaccessible areas. It states that the licensee is to 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."	Revise or update Element 1 of the AMP to include inaccessible areas of supports exempted from IWB-1220.
1.2: No further review item was identified.		
2. Preventive Actions		
Selection of bolting material and the use of lubricants and sealants is in accordance with the guidelines of EPRI NP-5769, EPRI TR-104213, and the additional recommendations of NUREG-1339 to prevent or mitigate degradation and failure of safety-related bolting. Operating experience and laboratory examinations show that the use of molybdenum disulfide (MoS2) as a lubricant is a potential contributor to stress corrosion cracking (SCC), especially when applied to high strength bolting. Thus, molybdenum disulfide and other lubricants containing sulfur should not be used. Preventive measures also include using bolting material that has an actual measured yield strength less than150 ksi or 1,034 MPa. Structural bolting replacement and maintenance activities include appropriate preload and proper tightening (torque or tension) as recommended in EPRI documents, American Society for Testing of Materials (ASTM) standards, American Institute of Steel Construction (AISC) Specifications, as applicable. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and stress corrosion cracking potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication "Specification for Structural Joints Using ASTM A325 or A490 Bolts" need to be used.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2.1: (Ginna plant visit) The licensee cleaned and painted all component anchor bolts located in the sub-basement to stop corrosion. This is a good practice and should be used on a generic basis and recommended in GALL revision.	Corrosion of anchor bolts is managed by VT-3 visual inspection. Painting of the anchor bolting would prevent corrosion from occurring and is a good practice. The following statement could be added in the program element to reflect the good practice: "Although corrosion of anchor bolts in managed by VT-3 visual inspection, cleaning and painting all support anchor bolts is considered a good practice and is recommended for stopping corrosion."	Revise or update the AMP program element.
3. Parameters Monitored/Inspected		
The parameters monitored or inspected include corrosion; deformation; misalignment of supports; missing, detached, or loosened support items; improper clearances of guides and stops; and improper hot or cold settings of spring supports and constant load supports. Accessible areas of sliding surfaces are monitored for debris, dirt, or indications of excessive loss of material due to wear that could prevent or restrict sliding as intended in the design basis of the support. Elastomeric vibration isolation elements are monitored for cracking, loss of material, and hardening. Structural bolts are monitored for corrosion and loss of integrity of bolted connections due to self-loosening and material conditions that can affect structural integrity. High-strength structural bolting (actual measured yield strength greater than or equal to 150 ksi or 1,034 MPa) susceptible to SCC should be monitored for SCC.		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
The program requires that a sample of ASME Class 1, 2, and 3 component supports that are not exempt from examination and 100% of MC component supports be examined as specified in Table IWF-2500-1. The sample size examined for ASME Class 1, 2, and 3 component supports is as specified in Table IWF-2500-1. The extent, frequency, and examination methods are designed to detect, evaluate, or repair age-related degradation before there is a loss of component support intended function. The VT-3 examination method specified by the program can reveal loss of material due to corrosion and wear, verification of clearances, settings, physical displacements, loose or missing parts, debris or dirt in accessible areas of the sliding surfaces, or loss of integrity at bolted connections. The VT-3 examination can also detect loss of material and cracking of elastomeric vibration isolation elements. VT-3 examination of elastomeric vibration isolation elements should be supplemented by feel to detect hardening if the vibration isolation function is suspect. IWF-3200 specifies that visual examinations that detect surface flaws, which exceed acceptance criteria may be supplemented by either surface or volumetric examinations to determine the character of the flaw. For high strength structural bolting (actual measured yield strength greater than or equal to 150 ksi or 1,034 MPa) in sizes greater than 1 inch nominal diameter, volumetric examination comparable to that of ASME Code Section XI, Table IWB-2500-1, Examination Category B-		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
G-1 should be performed to detect cracking in addition to the VT-3 examination. This volumetric examination may be waived with adequate plant-specific justification. Other structural bolting (ASTM A-325, ASTM F1852, and ASTM A490 bolts) and anchor bolts are monitored for loss of material, loose or missing nuts, and cracking of concrete around the anchor bolts.		
4.1: (Ginna plant visit) The GALL, Rev. 2, is augmented to include monitoring of high-strength structural bolting based on NUREG-1339 and industry recommendations. Ginna's IWF AMP is based on GALL, Rev. 0, and monitoring of high-strength bolting is not included in the program basis documents. The licensee should update program basis documents to reflect changes in later versions of the GALL (this is a generic implementation issue).	High-strength bolting may experience SCC and should be included in the program. The program description of the GALL may add the following statement to reflect this need: "For AMP programs developed based on previous GALL versions, licensees may require updates to include monitoring of the high-strength bolting for detecting SCC."	Revise the program description to reflect the need for monitoring high-strength bolting.
4.2: (NMP-1 plant visit) NMP-2 has performed EPU. During the audit session of Appendix J session, NMP-1 engineers stated that the test pressure of Appendix J in NMP-2 is increased due to EPU effects. The GALL does not address the impact of EPU on the detection of aging effects.	Increasing loadings at equipment and piping supports may impact the AMP (e.g., require more frequent inspections). The following statement should be added to reflect the need to take EPU modifications into consideration: "For plants with EPU modifications, more frequent inspections may be required to account for high loadings in the support components."	Revise the program description to reflect the need for considering impacts of EPU.
5. Monitoring and Trending		
The ASME Class 1, 2, 3, and MC component supports are examined periodically, as specified in Table IWF-2500-1. As required by IWF-2420(a), the sequence of component support examinations established during the first inspection interval is repeated during each successive inspection interval, to the extent practical. Component supports whose examinations do not reveal unacceptable degradations are accepted for continued service. Verified changes of conditions from prior examination are recorded in accordance with IWA-6230. Component supports whose examinations reveal unacceptable conditions and are accepted for continued service by corrective measures or repair/replacement activity are reexamined during the next inspection period. When the reexamined component support no longer requires additional corrective measures during the next inspection period, the inspection schedule may revert to its regularly scheduled inspection. Examinations that reveal indications, which exceed the acceptance standards and require corrective measures are extended to include additional examinations in accordance with IWF-2430.		
5.1: No further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
6. Acceptance Criteria		
The acceptance standards for visual examination are specified in IWF-3400. IWF-3410(a) identifies the following conditions as unacceptable: (a) Deformations or structural degradations of fasteners, springs, clamps, or other support items; (b) Missing, detached, or loosened support items, including bolts and nuts; (c) Arc strikes, weld spatter, paint, scoring, roughness, or general corrosion on close tolerance machined or sliding surfaces; (d) Improper hot or cold positions of spring supports and constant load supports; (e) Misalignment of supports; and (f) Improper clearances of guides and stops. Other unacceptable conditions include: (a) Loss of material due to corrosion or wear, which reduces the load bearing capacity of the component support; (b) Debris, dirt, or excessive wear that could prevent or restrict sliding of the sliding surfaces as intended in the design basis of the support; (c) Cracked or sheared bolts, including high strength bolts, and anchors; and (d) Loss of material, cracking, and hardening of elastomeric vibration isolation elements that could reduce the vibration isolation function. The above conditions may be accepted provided the technical basis for their acceptance is documented.		
6.1: No further review item was identified.		
7. Corrective Actions		
Identification of unacceptable conditions triggers an expansion of the inspection scope, in accordance with IWF-2430, and reexamination of the supports requiring corrective actions during the next inspection period, in accordance with IWF-2420(b). In accordance with IWF-3122, supports containing unacceptable conditions are evaluated or tested or corrected before returning to service. Corrective actions are delineated in IWF-3122.2. IWF-3122.3 provides an alternative for evaluation or testing to substantiate structural integrity and/or functionality. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
To date, IWF sampling inspections have been effective in managing aging effects for ASME Class 1, 2, 3, and MC supports. There is reasonable assurance that the Subsection IWF inspection program will be effective in managing the aging of the in-scope component supports through the period of extended operation. Degradation of threaded bolting and fasteners has occurred from boric acid corrosion, SCC, and fatigue loading (NRC IE Bulletin 82-02, NRC Generic Letter 91-17). SCC has occurred in high strength bolts used for NSSS component supports (EPRI NP-5769).		
10.1: NRC IN 2009-04, "Age-Related Constant Support Degradation," dated Feb. 18, 2009, describes deviations in the supporting forces due to wear on the linkage and increased friction between the various moving parts and joints within the constant support.	NRC IN 2009-04 should be included in the Operating Experience	Revise or update the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards,* Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWB, *Requirements for Class 1 Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWC, *Requirements for Class 2 Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWD, *Requirements for Class 3 Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components,* Subsection IWE, *Requirements for Class MC and Metallic Liners of Class CC Components of Light-Water Cooled Power Plants,* The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, Subsection IWF, Requirements for Class 1, 2, 3, and MC Component Supports of Light-Water Cooled Power Plants, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

EPRI NP-5067, *Good Bolting Practices, A Reference Manual for Nuclear Power Plant Maintenance Personnel*, Volume 1: Large Bolt Manual, 1987; Volume 2: Small Bolts and Threaded Fasteners, Electric Power Research Institute, 1990.

EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volumes 1 and 2, Electric Power Research Institute, April 1988.

EPRI TR-104213, *Bolted Joint Maintenance & Application Guide*, Electric Power Research Institute, December 1995.

NRC Generic Letter 91-17, *Generic Safety Issue **29**, Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, October 17, 1991.

NRC Morning Report, *Failure of Safety/Relief Valve Tee-Quencher Support Bolts*, March 14, 2005. (ADAMS Accession Number ML050730347)

NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, June 1990.

RCSC (Research Council on Structural Connections): *Specification for Structural Joints Using ASTM A325 or A490 Bolts,* Chicago, 2004.

Additional Reference

NRC Information Notice 2009-04, *Age Related Constant Support Degradation,* U.S. Nuclear Regulatory Commission, Washington, DC, February 18, 2009.

A.43 XI.S4 10 CFR 50, Appendix J

The verbatim text of GALL, Rev. 2, AMP XI.S4 for 10 CFR 50, Appendix J, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
As described in 10 CFR Part 50, Appendix J, containment leak rate tests are required to "assure that (a) leakage through these containments or systems and components penetrating these containments does not exceed allowable leakage rates specified in the technical specifications and (b) integrity of the containment structure is maintained during its service life." Appendix J provides two options, Option A and Option B, either of which can be chosen to meet the requirements of a containment leakage rate test (LRT) program. Option A is prescriptive with all testing performed on specified, uniform periodic intervals. Option B is a performance-based approach. Some of the differences between these options are discussed below. More detailed information for Option B is provided in the Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.163 and NEI 94-01 as approved by the NRC Final Safety Evaluation for the Nuclear Energy Institute (NEI) Topical Report (TR) 94-01, Revision 2. Three types of tests are performed under either Option A or Option B. Type A tests are performed to determine the overall primary containment integrated leakage rate at the loss of coolant accident peak containment pressure. Type B tests are intended to detect local leaks and to measure leakage across each pressure-containing or leakage-limiting boundary of containment penetrations. Type C tests are intended to detect local leaks and to measure leakage across containment isolation valves installed in containment penetrations or lines penetrating containment. If Type C tests are not performed under this program, they could be included under an ASME Code, Section XI, Inservice Test Program leakage testing for systems containing the isolation valves. Appendix J requires a general inspection of the accessible interior and exterior surfaces of the containment structure and components be performed prior to any Type A test. General Visual examinations performed in accordance with the ASME Section XI, Subsection IWE (AMP XI.S1) or ASME Section XI, Subsection IWL (AMP XI.S2) program are an acceptable substitute. The purpose of the inspection is to uncover any evidence of structural deterioration that may affect the containment structural integrity or leak-tightness. If there is evidence of structural deterioration, the Type A test is not performed until corrective action is taken in accordance with the repair/replacement procedures.		
a.1: (Ginna plant visit) A typical reactor containment consists of over 100 electrical and mechanical penetrations, two or three equipment hatches, and personnel air locks.	The following paragraphs should be inserted at the beginning of the program description to point out the importance of tracking the degradation and objectives of	Revise or update program

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The containment can be subjected to various types of aging degradation, depending on the inherent characteristics of the materials, the fabrication processes, and the construction methods. One key important factor of containment aging management is that the test results of Appendix J must be compared with previous results to examine the performance history of the overall containment system to limit leakage and to track the degradation. GALL needs to stress the importance of tracking the performance history of containments systems.	Appendix J: "A typical reactor containment consists of a containment structure, over 100 electrical and mechanical penetrations, two or three equipment hatches, and personnel air locks. The containment can be subjected to various types of aging degradation, depending on the inherent characteristics of the materials, fabrication processes, and construction methods. The rate and extent of degradation are influenced by sustained environmental conditions such as temperature, humidity, water leakage, and borated water spills. To ensure reliability of the containment, it is necessary to track the degradation of the containment components through periodic inspections and check the leak-tight integrity of the containment's pressure-retaining components through periodic leak rate testing. The objective of Appendix J is to identify and quantify leakage through primary containment, as well as systems and components penetrating primary containment, to ensure containment will perform its isolation safety function. This is accomplished by the following: 1. Performing Type B or Type C Testing of individual components. 2. Monitoring leakage for indication of degradation. 3. Implementing corrective actions necessary to manage Types B and C summary total within established acceptance criteria. 4. Performing the Type A Test for an Integrated Leak Rate Test (ILRT) periodically to verify total containment structure and penetration tightness."	description.
a.2: (Ginna plant visit) More detailed explanations of the program description are necessary, including the objectives of the ISI.	Add additional details (underlined) in the program description, as follows: Appendix J provides two options, Option A <u>(deterministic-</u>	Revise or update the program

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	based) and Option B (performance-based), either of which can be chosen to meet the requirements of a containment leakage rate test (LRT) program. Option A is prescriptive with all testing performed on specified, uniform periodic intervals. Option B is a performance-based approach. Some of the differences between these options are discussed below. More detailed information for Option B is provided in the NRC RG 1.163 and NEI 94-01 as approved by the NRC Final Safety Evaluation for the Nuclear Energy Institute (NEI) Topical Report (TR) 94-01, Rev. 2. Three types of tests are performed under either Option A or B. Type A tests (integrated leak rate testing, ILRT) are performed to determine the overall primary containment integrated leakage rate at the loss of coolant accident peak containment pressure. Type B tests (containment penetration leak rate testing) are intended to detect local leaks and to measure leakage across each pressure-containing or leakage-limiting boundary of containment penetrations. Type C tests (containment isolation valve leak rate testing) are intended to detect local leaks and to measure leakage across containment isolation valves installed in containment penetrations or lines penetrating containment. If Type C tests are not performed under this program, they could be included under an ASME Code, Section XI, Inservice Test Program leakage testing for systems containing the isolation valves. Appendix J requires a general visual inspection of the accessible interior and exterior surfaces of the containment structure and components be performed prior to any Type A test in order to allow early detection of structural and component degradation.	description.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	General Visual examinations performed in accordance with the ASME Section XI, Subsection IWE (AMP XI.S1) or ASME Section XI, Subsection IWL (AMP XI.S2) program are an acceptable substitute. The purpose of the inspection is to uncover any evidence of structural deterioration that may affect the containment structural integrity or leak-tightness. If there is evidence of structural deterioration, the Type A test is not performed until corrective action is taken in accordance with the repair/replacement procedures. The ISI, together with the Appendix J leak rate test, is to ensure containment integrity.	
Program Basis Documents and/or Supporting Documents		
As part of the program description, the GALL, Rev. 2, AMP includes guidance from NRC RG 1.163, Rev. 0, 1995, and NEI 94-01, Rev. 2A, 2008.		
b.1: Although the GALL AMP provides guidance based on NRC RG 1.163 and NEI 94-01, the AMP does not provide guidance on the acceptable methods and techniques of performing Types A, B, and C containment leakage testing.	It would be helpful to point out in the program description that the acceptable method and techniques for performing Types A, B, and C containment leakage testing are documented in ANSI/ANS-56.8. (Add ANSI/ANS-56.8 to the references.)	Revise or update the program description.
Program Consistency and Commitments		
The AMP for both Ginna and NMP-1 plants is consistent with GALL, Rev. 0, AMP XI.S4, 10 CFR 50, Appendix J, and there are no commitments in the SER for this program.		
c.1: No further review item was identified.		
1. Scope of Program		
The scope of the containment LRT program includes all containment boundary pressure-retaining components.		
1.1: The GALL program element does not provide a list of the containment boundary pressure-retaining components.	Provide a list of containment boundary pressure-retaining components in the scope of program. The scope of the containment LRT program includes all	Revise or update the AMP program

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	containment boundary pressure-retaining components that consist of containment structure, all penetrations, equipment hatches, personnel air locks, and containment isolation valves.	element.
2. Preventive Actions		
The containment LRT program is a performance monitoring program that includes no preventive actions.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
The parameters to be monitored are leakage rates through containment shells, containment liners, and associated welds, penetrations, fittings, and other access openings.		
3.1: The GALL program element only suggests monitoring of leakage rates from the containment pressure test. More parameters need to be monitored because Appendix J of the AMP also involves ISI visual inspection.	Add additional aging effects to be monitored. These include loss of material due to general corrosion, stress corrosion cracking (SCC), loss of sealing, elastomer degradation, and loss of leak tightness due to other material degradation.	Revise or update the AMP program element.
4. Detection of Aging Effects		
A containment LRT program is effective in detecting leakage rate of the containment pressure boundary components, including seals and gaskets. While the calculation of leakage rates and satisfactory performance of containment leakage rate testing demonstrates the leak-tightness and structural integrity of the containment, it does not by itself provide information that would indicate that aging degradation has initiated or that the capacity of the containment may have been reduced for other types of loads, such as seismic loading. This would be achieved with the additional implementation of an acceptable containment inservice inspection program as described in ASME Section XI, Subsection IWE (AMP XI.S1) and ASME Section XI, Subsection IWL (AMP XI.S2).		
4.1: (NMP-1 plan audit) The GALL program element states that the leakage rate test does not by itself provide information that would indicate that aging degradation has initiated. This statement may be misleading. Based on NMP-1 program basis documents, Type B tests are sensitive and able to detect degraded components that impact component leak tightness and identifies those requiring corrective actions.	Remove the statement that the leakage rate test does not by itself provide information that would indicate that aging degradation has initiated. Instead, state that Type B tests are sensitive and able to detect degradations due to aging effects. Once degradations are detected, they should be tracked. Additional implementation of ISI programs of ASME Section XI, Subsection IWE (AMP XI.S1), and ASME Section XI, Subsection IWL (AMP XI.S2), will further	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	assist detection of aging effects.	
4.2: (NMP-1 plan audit) The GALL program element does not provide guidelines on the acceptable method and techniques for performing Type A, B, and C containment leakage testing that are documented in ANSI/ANS-56.8.	Provide a statement in the program element that the acceptable method and techniques for performing Type A, B, and C containment leakage testing are documented in ANSI/ANS-56.8.	Revise or update the AMP program element.
4.3: The GALL element has no detailed guidelines on test frequencies of Type A, B, C tests on various components. There are some differences between RG 1.163 and NEI 94-01 regarding the test frequencies of Appendix J.	Provide guidelines on test frequencies of Type A, B, and C tests based on RG 1.163 and NEI 94-01. Below are two examples of test frequencies that should be added to the program element. "In Option B, the periodic Type A test interval can be increased to 10 years based on performance history of the Type A tests as defined in NEI 94-01. For Penetrations, Type B tests are performed at least once every 24 months on each penetration. The test interval can be extended to 10 years based on the performance history of individual penetrations. Tests of containment air locks and their components are performed once every 24 months." "For Type C tests, the maximum interval between tests for BWR main steam and feedwater isolation valves, and PWR and BWR containment purge and vent valves, is limited to 30 months. For other types of isolation valves, the maximum test interval is limited to 5 years based on RG 1.163."	Revise or update the AMP program element. (Guidelines on test frequencies should not be provided in the AMP; referring to RG 1.163 and NEI 94-01 is sufficient)
4.4: (NMP-1 plant visit) The GALL needs to address the impact of EPU on the Appendix J testing.	The following statement is recommended to reflect the need to take EPU modifications into consideration: "For plants with EPU modification, the effects of EPU on Appendix J testing should be taken into consideration.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	Plants with EPU modification have increased test pressure."	
4.5: (Ginna plant audit) The GALL does not provide guidance on qualification of inspectors. For Appendix J, Type A test concrete surface examination defines the inspector qualifications. Inspectors should be qualified in accordance with ASME Section XI, IWA 3200.	It is recommended that the inspector for Appendix J testing is qualified in accordance with ASME Section XI, IWA 3200.	Revise or update the AMP program element.
5. Monitoring and Trending		
Because the LRT program is repeated throughout the operating license period, the entire pressure boundary is monitored over time. The frequency of these tests depends on which option (A or B) is selected. With Option A, testing is performed on a regular fixed time interval as defined in 10 CFR Part 50, Appendix J. In the case of Option B, the interval for testing may be adjusted on the basis of acceptable performance in meeting leakage limits in prior tests. Additional details for implementing Option B are provided in NRC RG 1.163 and NEI 94-01.		
5.1: The GALL program element does not provide guidance of trending. Trending for the 10 CFR 50, Appendix J program is important, as stated in 10 CFR 50 Appendix J: "The test results must be compared with previous results to examine the performance history of the overall containment system to limit leakage."	The following statements should be added: "It is necessary to track the degradation of the containment components through periodic inspections and check the leak-tight integrity of the containment's pressure-retaining components through periodic leak rate testing. Trending for the 10 CFR 50, Appendix J program are important as stated in 10 CFR 50 Appendix J: "The test results must be compared with previous results to examine the performance history of the overall containment system to limit leakage.""	Revise or update the program description to reflect the importance of tracking and trending.
6. Acceptance Criteria		
Acceptance criteria for leakage rates are defined in plant technical specifications. These acceptance criteria meet the requirements in 10 CFR Part 50, Appendix J, and are part of each plant's current licensing basis.		
6.1: No further review item was identified.		
7. Corrective Actions		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
To date, the 10 CFR Part 50, Appendix J, LRT program, in conjunction with the containment inservice inspection program, has been effective in preventing unacceptable leakage through the containment pressure boundary. Implementation of Option B for testing frequency must be consistent with plant-specific operating experience.		
10.1: (NMP-1 plant audit) The GALL program element does not provide examples of leakage of the containment pressure boundary. The NMP-1 basis document lists the following leakage cases in NMP-1: Leakages on the main steam penetration bellows were detected by Type B test due to cracks in the heat-affected zone of seam welds. Interior wall leak paths were identified through Type A tests. Torus leakages have been reported due to fatigue in the proximity of the HPCI System line. Type C tests (containment isolation valve) are the most common failure events. Typical corrective actions involve valve disc to seat maintenance to improve leak tightness.	Include the containment leakage cases in the GALL program element based on NMP-1 operating experience.	Revise or update the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR Part 50, Appendix J, *Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.72, *Immediate Notification Requirements for Operating Nuclear Power Reactors,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.73, *Licensee Event Report System,* Office of the Federal Register, National Archives and Records Administration, 2009.

Final Safety Evaluation for 'Nuclear Energy Institute (NEI) Topical Report (TR) 94-01, Revision 2, *Industry Guideline for Implementing Performance-Based*

Option of 10 CFR, Part 50, Appendix J,' and 'Electric Power Research Institute (EPRI) Report No. 1009325, Revision 2, *Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals*, August 2007,' June 25, 2008.

NEI 94-01, Rev. 2-A, *Industry Guideline for Implementing Performance-Based Option of 10 CFR Part 50 Appendix J,* Nuclear Energy Institute, August 2007*.

NRC Regulatory Guide 1.163, Rev. 0, *Performance-Based Containment Leak-Test Program,* U.S. Nuclear Regulatory Commission, September 1995.

Additional Reference

ANSI/ANS-56.8-2002, *Containment System Leakage Test Requirements,* American Nuclear Society, La Grange Park, IL, 2002.

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* This report was issued October 2008.

A.44 XI.S5 Masonry Walls

The verbatim text of GALL, Rev. 2, AMP XI.S5, Masonry Walls, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Nuclear Regulatory Commission (NRC) IE Bulletin (IEB) 80-11, "Masonry Wall Design," and NRC Information Notice (IN) 87-67, "Lessons Learned from Regional Inspections of Licensee Actions in Response to IE Bulletin 80-11," constitute an acceptable basis for a masonry wall aging management program (AMP). IEB 80-11 required (a) the identification of masonry walls in close proximity to or having attachments from safety-related systems or components and (b) the evaluation of design adequacy and construction practice. NRC IN 87-67 recommended plant-specific condition monitoring of masonry walls and administrative controls to ensure that the evaluation basis developed in response to NRC IEB 80-11 is not invalidated by (a) deterioration of the masonry walls (e.g., new cracks not considered in the reevaluation), (b) physical plant changes such as installation of new safety-related systems or components in close proximity to masonry walls, or (c) reclassification of systems or components from non-safety-related to safety-related, provided appropriate evaluation is performed to account for such occurrences. Important elements in the evaluation of many masonry walls during the NRC IEB 80-11 program included (a) installation of steel edge supports to provide a sound technical basis for boundary conditions used in seismic analysis and (b) installation of steel bracing to ensure stability or containment of unreinforced masonry walls during a seismic event. Consequently, in addition to the development of cracks in the masonry walls, loss of function of the structural steel supports and bracing would also invalidate the evaluation basis. The steel edge supports and steel bracings are considered component supports and aging effects are managed by the Structures Monitoring program (AMP XI.S6). The program requires periodic visual inspection of masonry walls in the scope of license renewal to detect loss of material and cracking of masonry units and mortar. The aging effects that could impact masonry wall intended function or potentially invalidate its evaluation basis are entered in the corrective action process for further analysis, repair, or replacement. Since the issuance of NRC IEB 80-11 and NRC IN 87-67, the NRC promulgated 10 CFR 50.65, the Maintenance Rule. For license renewal, masonry walls may be inspected as part of the “Structures Monitoring Program” (AMP XI.S6) conducted for the Maintenance Rule, provided the 10 attributes described below are incorporated in AMP XI.S6. The aging effects on masonry walls that are considered fire barriers also are managed by AMP XI.M26, Fire Protection.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.1: (NMP-1 plant audit) Removal or relocation of piping being supported on the masonry wall is also one of the methods of reinforcing the wall. This method should be mentioned.	Revise the program element to read as follows: "Important elements in the evaluation/modification of masonry walls during the NRC IEB 80-11 program included (a) installation of steel edge supports to provide a sound technical basis for boundary conditions used in seismic analysis and (b) installation of steel bracing to ensure stability or containment of unreinforced masonry walls during a seismic event, and (c) removal or relocation of piping being supported on the wall."	Revise or update the program description.
a.2: (NMP-1 plant visit) The GALL program description states that aging effects on masonry walls that are considered fire barriers also are managed by AMP XI.M26, Fire Protection. However, the program description and scope of program of AMP XI.M26, Fire Protection does not include fire-barrier masonry walls.	Add fire-barrier masonry walls to the program description and scope of program of AMP XI.M26, Fire Protection.	Revise or update AMP XI.M26, Fire Protection.
Program Basis Documents and/or Supporting Documents		
IE Bulletin (IEB) 80-11, "Masonry Wall Design," and NRC Information Notice (IN) 87-67.		
b.1: No further review item was identified.		
Program Consistency and Commitments		
NMP-1 LR Commitment #39: Inspection of safety-related un-reinforced and un-braced masonry walls every 4 years. The Masonry Wall Program (as managed by the Structures Monitoring Program) will be enhanced to provide guidance for inspecting NMP-1 non-reinforced masonry wails walls that do not have bracing and are within scope of license renewal more frequently than the reinforced masonry walls.		
c.1: (NMP-1 plant visit) Inspection of safety-related un-reinforced and un-braced masonry walls in NMP-1 is more frequent than the reinforced walls.	Recommend more frequent inspections of safety-related un-reinforced and un-braced masonry walls in the program element "Detection of Aging Effects."	Revise the AMP program element.
1. Scope of Program		
The scope includes all masonry walls identified as performing intended functions in accordance with 10 CFR 54.4. The aging effects on masonry walls that are considered fire barriers also are managed by AMP XI.M26, Fire Protection, as well as being managed by this		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
program.		
1.1: (NMP-1 plant audit) Components of masonry walls are not defined.	Change the following statements: The program manages all of the masonry walls within the scope of 10 CFR 54.4, including those masonry walls applicable to the concerns of NRC IE-Bulletin 80-11, "Masonry Wall Design," and the walls that provide protection against fire per 10 CFR 50.48. Masonry walls consists of solid or hollow concrete block, mortar, grout, steel bracing, and supports.	Revise or update the AMP program element.
2. Preventive Actions		
This is a condition monitoring program and no specific preventive actions are required.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
The primary parameters monitored are potential shrinkage and/or separation and cracking of masonry walls and gaps between the supports and masonry walls that could impact the intended function or potentially invalidate its evaluation basis.		
3.1: (NMP-1 plant audit) Parameters monitored/inspected for structural steel of the masonry wall need to be recommended.	Structural steel of masonry walls is inspected for notable deflection or distortion, loose bolts, corrosion, and degradation of coating.	Revise or update the AMP program element.
4. Detection of Aging Effects		
Visual examination of the masonry walls by qualified inspection personnel is sufficient. In general, masonry walls should be inspected every 5 years, with provisions for more frequent inspections in areas where significant loss of material or cracking is observed to ensure there is no loss of intended function between inspections. However, masonry walls that are fire barriers are visually inspected in accordance with AMP XI.M26.		
4.1: (NMP-1 plant audit) NMP-1 inspects the un-reinforced and un-braced masonry walls within the scope of license renewal more frequently than the reinforced masonry walls based on LRA RAI recommendation.	It is recommended in the GALL program element that un-reinforced and un-braced masonry walls within the scope of license renewal be inspected more frequently than the reinforced masonry walls.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
4.2: (NMP-1 plant audit) The GALL program element does not provide guidance on inspection of masonry walls after seismic event.	Following a seismic event, an inspection should be conducted in assessing conditions of the masonry walls, and further evaluation should be performed if degradation is found, as described in NRC RG 1.167.	Revise the AMP program element.
5. Monitoring and Trending		
Trending is not required. Condition monitoring for evidence of shrinkage and/or separation and cracking is achieved by periodic examination. Degradation detected from monitoring is evaluated.		
5.1: (NMP-1 plant audit) The GALL program element states that trending is not required. On the contrary, trending is important and should be recommended.	In the GALL program element, older checklists should be compared to recent checklists for trending purposes and to verify whether there are any changes in the conditions of the masonry walls. The checklists are also compared to the respective calculations developed for the respective masonry walls during the resolution of IEB 80-11. This practice is in the basis document of NMP-1.	Revise or update the AMP program element.
6. Acceptance Criteria		
For each masonry wall, the extent of observed shrinkage and/or separation and cracking of masonry may not invalidate the evaluation basis or impact the wall's intended function. However, further evaluation is conducted if the extent of cracking and loss of material is sufficient to impact the intended function of the wall or invalidate its evaluation basis.		
6.1: (NMP-1 plant audit) The GALL program element is vague. It needs to provide guidelines on more specific acceptance criteria.	Acceptance criteria should be provided, such as the following: Each wall should be assessed against its design basis to confirm that aging effects of masonry walls (i.e., shrinkage and/or separation and cracking of masonry walls and gaps between the supports and masonry wall) have not significantly undermined the design basis assumptions. Installation of any safety-related equipment near or adjacent to masonry walls requires additional evaluation against the original design bases. For masonry wall serving as a fire barrier, any missing blocks, mortar, or cracks in the wall that cause a clear	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
	opening within the wall are considered unacceptable and require corrective action. The applicable calculation (i.e., evaluation basis) for each masonry wall should be kept on record. If degradation of the wall or associated steel is judged significant or of concern, then a review of the respective calculations and further evaluation are performed to determine the effect on the evaluation basis. Resolution of "use-as-is" or "acceptable with deficiencies" for degradation that appears "unacceptable" must be technically justified and approved by engineering analysis. If more sophisticated analysis methods such as Finite Element Analysis are used in the engineering analysis, it would be considered a new evaluation basis against seismic loads. The evaluation should consider the latest updated site seismic hazards.	
7. Corrective Actions		
A corrective action option is to develop a new analysis or evaluation basis that accounts for the degraded condition of the wall (i.e., acceptance by further evaluation). Other alternatives include repair or replacing the degraded wall. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
10. Operating Experience		
Since 1980, masonry walls that perform an intended function have been systematically identified through licensee programs in response to NRC IEB 80-11, NRC Generic Letter 87-02, and 10 CFR 50.48. NRC IN 87-67 documented lessons learned from the NRC IEB 80-11 program and provided recommendations for administrative controls and periodic inspection to ensure that the evaluation basis for each safety-significant masonry wall is maintained. NUREG-1522 documents instances of observed cracks and other deterioration of masonry-wall joints at nuclear power plants. Whether conducted as a stand-alone program or as a part of structures monitoring, a masonry wall AMP that incorporates the recommendations delineated in NRC IN 87-67 should ensure that the intended functions of all masonry walls within the scope of license renewal are maintained for the period of extended operation.		
10.1: No further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.48, *Fire Protection,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.65, *Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 54.4, *Scope*, Office of the Federal Register, National Archives and Records Administration, 2009.

NRC Generic Letter 87-02, *Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46,* U.S. Nuclear Regulatory Commission, February 19, 1987.

NRC Inspection and Enforcement Bulletin 80-11, *Masonry Wall Design,* U.S. Nuclear Regulatory Commission, May 8, 1980.

NRC Information Notice 87-67, *Lessons Learned from Regional Inspections of Licensee Actions in Response to IE Bulletin 80-11*, U.S. Nuclear Regulatory Commission, December 31, 1987.

NRC Regulatory Guide 1.160, Rev. 2*, Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,* U.S. Nuclear Regulatory Commission, March 1997.

NRC Regulatory Guide 1.167, *Restart of a Nuclear Power Plant Shut down by a Seismic Event,* U.S. Nuclear Regulatory Commission, March 1997.

NUMARC 93-01, Rev. 2, *Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants (Line-In/Line-Out Version),* Nuclear Energy Institute, April 1996.

NUREG-1522, *Assessment of Inservice Condition of Safety-Related Nuclear Power Plant Structures,* June 1995.

A.45 XI.S6 Structure Monitoring

The verbatim text of GALL, Rev. 2, AMP XI.S6, Structures Monitoring, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Implementation of structures monitoring under 10 CFR 50.65 (the Maintenance Rule) is addressed in Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.160, Rev. 2, and NUMARC 93-01, Rev. 2. These two documents provide guidance for development of licensee-specific programs to monitor the condition of structures and structural components within the scope of the Maintenance Rule, such that there is no loss of structure or structural component intended function. The structures monitoring program consists of periodic visual inspections by personnel qualified to monitor structures and components for applicable aging effects, such as those described in the American Concrete Institute Standards (ACI) 349.3R, ACI 201.1R, and American National Standards Institute/American Society of Civil Engineers Standard (ANSI/ASCE) 11. Visual inspections should be supplemented with volumetric or surface examinations to detect stress corrosion cracking (SCC) in high strength (actual measured yield strength greater than or equal to 150 kilo-pound per square inch [ksi] or greater than or equal to 1,034 MPa) structural bolts greater than 1 inch (25 mm) in diameter. Identified aging effects are evaluated by qualified personnel using criteria derived from industry codes and standards contained in the plant current licensing bases, including ACI 349.3R, ACI 318, ANSI/ASCE 11, and the American Institute of Steel Construction (AISC) specifications, as applicable. The program includes preventive actions delineated in NUREG-1339 and in Electric Power Research Institute (EPRI) NP-5769, NP-5067, and TR-104213 to ensure structural bolting integrity, if applicable. The program also includes periodic sampling and testing of ground water and the need to assess the impact of any changes in its chemistry on below grade concrete structures. If protective coatings are relied upon to manage the effects of aging for any structures included in the scope of this aging management program (AMP), the structures monitoring program is to address protective coating monitoring and maintenance.		
a.1: (NMP-1 plant audit) SER Sec. 3.0.3.2.21 (Structures Monitoring Program) states that the program provides for visual inspections and <u>surveys</u>, and examination of all	Include surveys as an additional method to detect aging effects. This needs to explore the scope of surveys, the parameters for monitoring, methods and frequency of survey, acceptance criteria, and corrective actions if	Update or revise the AMP program description to

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

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building and structures within the scope of license renewal. The GALL AMP does not include surveys in detection of aging effects. Including surveys in the AMP is a "strength" of NMP-1.	acceptance criteria are not met. Examples of surveys may include displacements of sliding surfaces, and seismic gaps between buildings.	include surveys.
a.2: (NMP-1 plant audit) Groundwater penetration/leakage occurs frequently in the plants. It could become a severe problem as plants get older. Examples of recent operating experience with groundwater penetration/leakage include the following: 1. An NRC 2011 inspection report revealed that groundwater penetration to underground electric tunnel at Seabrook plant caused concrete to lose more than 20 percent of its strength. The degradation is due to sulfate attack when concrete is saturated in water. 2. NMP-1 Plant Operating Experience (SER 3.0.3.2.21): - Minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels. - Several CRs have identified minor cracking in concrete structures including the service water pipe tunnel, which is susceptible to small wall cracks that allow leakage of groundwater. - Groundwater has entered switchgear building, service water tunnels, and the radwaste building of below-grade exterior walls. These operating experiences indicate that the Structures Monitoring AMP may need to be enhanced in dealing with groundwater penetration/leakage.	Aging management should be addressed in dealing with groundwater penetration/leakage, and guidelines should be provided using the lessons learned from the Seabrook plant and other operating experience. Aging management of structures due to groundwater penetration/leakage would be an important task in the Structures Monitoring Program. It would affect Scope of Program, Parameters Monitor/Inspected, Detection of Aging Effects, Acceptance Criteria, Corrective Actions, and OE.	Update or revise the program description to include management of groundwater leakage.
Program Basis Documents and/or Supporting Documents		
Strength of NMP-1 AMP: Based on NRC IE Bulletin 80-10, routine sampling/analysis of groundwater conditions are performed in NMP-1 on groundwater wells to identify any radioactive contamination in the groundwater. The groundwater is sampled at least once every 6		

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months for corrosive indicators. This is in contrast with the 5-year intervals recommended in the GALL (with NRC IE Bulletin 80-10 as an additional reference). Based on the applicability of IN 97-11 and 98-26, inspection should include examination of structures and interfaces between structures, when accessible, for signs of building settlement and/or differential settlement.		
b.1: The GALL does not contain IN 97-11 and 98-26.	Add IN 97-11 and 98-26 to the references and provide guidance in the AMP on examination for signs of building settlement and/or differential settlement based on IN 97-11 and 98-26.	Update or revise the AMP program description.
Program Consistency and Commitments		
Ginna: Enhance Structures Monitoring Program to include all structures within the scope of license renewal, and provide additional guidance for detecting aging effects. NMP-1: (1) Enhance the Bolting Integrity Program to (a) enhance the Structures Monitoring, Preventive Maintenance and Systems Walk-down Programs to include requirements to inspect bolting for indication of loss of preload, cracking, and loss of material, as applicable; (b) include in the NMP-1 administrative and implementing program documents references to the Bolting Integrity Program and Industry guidance; and (c) establish an augmented inspection program for high-strength (actual yield strength a 150 ksi) bolts. This augmented program will prescribe the examination requirements of Tables IWB-2500-1 and IWC-2500-1 of ASME Section SI for high-strength bolts In the Class 1 and Class 2 component supports, respectively. (2) Enhance the Structures Monitoring Program to (a) expand the program to include the following activities or components In the scope of license renewal but not within the current scope of 10 CFR 50.65: (i) Fire Rated Assemblies & Watertight Penetration Visual Inspections, (ii) masonry walls in the turbine building and service water tunnel serving a fire barrier function, (iii) the steel electrical transmission towers required for the SBO and recovery; (b) expand the parameters monitored during structural inspections to include those relevant to aging effects identified for structural bolting; and (c) implement regularly scheduled groundwater monitoring to ensure that a benign environment is maintained. (3) Develop and implement a Wooden Power Pole Inspection Program to manage the aging of wooden power poles that are within the scope for license renewal because they provide structural support for the transmission lines in the recovery path for station blackout.		
c.1: The GALL AMP and AMR table do not include steel electrical transmission towers and wooden power poles. NMP-1 has a plant-specific Wooden Power Pole Inspection Program.	Based on the NMP-1 commitments, steel electrical transmission towers that are required for the SBO and recovery should be included in the AMP and AMR table. Aging management of wooden power poles based on the	Update AMP and AMR table.

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	NMP-1 Wooden Power Pole Inspection Program should also be included.	
1. Scope of Program		
The scope of the program includes all structures, structural components, component supports, and structural commodities in the scope of license renewal that are not covered by other structural AMPs (i.e., "ASME Section XI, Subsection IWE" (AMP XI.S1); "ASME Section XI, Subsection IWL" (AMP XI.S2); "ASME Section XI, Subsection IWF" (AMP XI.S3); "Masonry Walls" (AMP XI.S5); and NRC RG 1.127, "Inspection of Water-Control Structures Associated with Nuclear Power Plants" (AMP XI.S7). Examples of structures, structural components, and commodities in the scope of the program are concrete and steel structures, structural bolting, anchor bolts and embedments, component support members, pipe whip restraints and jet impingement shields, transmission towers, panels and other enclosures, racks, sliding surfaces, sump and pool liners, electrical cable trays and conduits, trash racks associated with water control structures, electrical duct banks, manholes, doors, penetration seals, and tube tracks. The applicant is to specify other structures or components that are in the scope of its structures monitoring program. The scope of this program includes periodic sampling and testing of ground water and may include inspection of masonry walls and water-control structures provided all the attributes of "Masonry Walls" (AMP XI.S5) and NRC RG 1.127, "Inspection of Water-Control Structures Associated with Nuclear Power Plants" (AMP XI.S7) are incorporated in the attributes of this program.		
1.1: (NMP-1 plant audit) SER Sec. 3.0.3.2.21 (Structures Monitoring Program) states that the program provides for visual inspections and surveys, and examination of all building and structures within the scope of license renewal. The GALL AMP does not include surveys in the AMP.	Include surveys in the AMP as an additional method to detect aging effects. This needs to explore the scope of surveys, parameters for monitoring, methods and frequency of survey, acceptance criteria, and corrective actions if acceptance criteria are not met. Examples of survey may include displacements of sliding surfaces, and seismic gaps between buildings.	Update the AMP program element to include surveys in the program scope.
1.2: Review of the topical report NUREG/CR-6927 "Primer on Durability of Nuclear Power Plant Reinforced Concrete Structures - A Review of Pertinent Factors" Feb. 2007 (Naus) indicates that a potential aging degradation mechanism, delayed ettringite formation (DEF), may occur for the concrete structures during the subsequent renewal. This degradation is caused by excessive heat curing that decomposes the ettringite in Portland cement during the hydration process. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion	Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate-to-aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment (Naus). The aging effects/mechanism due to DEF and the preventive measurements should be included in the AMPs.	Update or revise the AMP program element.

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and the destructive expansive forces crack the concrete. DEF was first reported in heat-cured railway ties in Germany in the early 1980s. Since then, several other countries, including the United States, have reported DEF problems in concrete structures (DOT News Letter, July 2004). The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.		
1.3: (Ginna plant audit) NMP-1 plant basis documents state that the Ginna Structure Monitoring AMP includes buried concrete, embedded steel, and structural components blocked by installed equipment or structures. Ginna considered the following in their AMP to manage aging effects in inaccessible areas: a. When "serious degradation in inaccessible areas" is identified from other utility plant inspections that may be of concern for this plant; b. When indicators exist that degradation may be occurring in an inaccessible area; and c. When an event occurs that could affect an inaccessible area, making it susceptible to degradation.	Recommended changes in GALL: 1. Spell out inaccessible areas in included embedded steel, and structural components blocked by installed equipment or structures. 2. Augment the program to include information about the following: d. When "serious degradation in inaccessible areas" is identified from other utility plant inspections that may be of concern for this plant; and e. When an event occurs that could affect an inaccessible area, making it susceptible to degradation.	Update or revise the AMP program element.
2. Preventive Actions		
The structures monitoring program is a condition monitoring program. The program should include preventive actions delineated in NUREG-1339 and in EPRI NP-5769, NP-5067, and TR-104213 to ensure structural bolting integrity, if applicable. These actions emphasize proper selection of bolting material, lubricants, and installation torque or tension to prevent or minimize loss of bolting preload and cracking of high strength bolting. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and stress corrosion cracking potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication "Specification for Structural Joints Using ASTM A325 or A490 Bolts," need to be used.		
2.1: (NMP-1 plant audit) Groundwater penetration/leakage	Provide preventive actions for stopping or mitigating	Update or

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could be a severe problem as plants get older. The GALL could suggest preventive actions for stopping or mitigating groundwater penetration/leakage, such as painting of the structural surfaces.	groundwater penetration/leakage.	revise the AMP program element.
2.2: The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate-to-aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment. The aging effects/mechanism due to DEF and the preventive measures should be included in the AMPs.	Revise or update the AMP program element.

3. Parameters Monitored/Inspected

For each structure/aging effect combination, the specific parameters monitored or inspected depend on the particular structure, structural component, or commodity. Parameters monitored or inspected are commensurate with industry codes, standards, and guidelines and also consider industry and plant-specific operating experience. ACI 349.3R and ANSI/ASCE 11 provide an acceptable basis for selection of parameters to be monitored or inspected for concrete and steel structural elements and for steel liners, joints, coatings, and waterproofing membranes (if applicable).

For concrete structures, parameters monitored include loss of material, cracking, increase in porosity and permeability, loss of foundation strength, and reduction in concrete anchor capacity due to local concrete degradation. Steel structures and components are monitored for loss of material due to corrosion. Structural bolting is monitored for loose bolts, missing or loose nuts, and other conditions indicative of loss of preload. High strength (actual measured yield strength ≥ 150 ksi or 1,034 MPa) structural bolts greater than 1 inch (25 mm) in diameter are monitored for SCC. Other structural bolting (ASTM A-325, ASTM F1852, and ASTM A490 bolts), and anchor bolts are monitored for loss of material, loose or missing nuts, and cracking of concrete around the anchor bolts. Accessible sliding surfaces are monitored for indication of significant loss of material due to wear or corrosion, debris, or dirt. Elastomeric vibration isolators and structural sealants are monitored for cracking, loss of material, and hardening. These parameters and other monitored parameters are selected to ensure that aging degradation leading to loss of intended functions will be detected and the extent of degradation can be determined. Ground water chemistry (pH, chlorides, and sulfates) are monitored periodically to assess its impact, if any, on below grade concrete structures. If necessary for managing settlement and erosion of porous concrete sub-foundations, the continued functionality of a site de-watering system is monitored. The plant-specific structures monitoring program should contain sufficient detail on parameters monitored or inspected to conclude that this program attribute is satisfied.

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3.1: (NMP-1 plant audit) SER Sec. 3.0.3.2.21 (Structures Monitoring Program) states that the program provides for visual inspections and surveys, and examination of all building and structures within the scope of license renewal. The GALL AMP does not include surveys to detect aging effects.	Include surveys as an additional method to detect aging effects. This needs to explore the scope of surveys, the parameters for monitoring, methods and frequency of survey, acceptance criteria, and corrective actions if acceptance criteria are not met. Examples of surveys may include displacements of sliding surfaces, and seismic gaps between buildings.	Update or revise the AMP program element to include monitoring parameters in surveys.
3.2: The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Include parameters monitored/inspected for DEF in the AMPs.	Revise or update the AMP program element.
3.3: (NMP-1) Based on the applicability of IN 97-11 and 98-26, inspection should include examination of structures and interfaces between structures, when accessible, for signs of building settlement and/or differential settlement (NMP).	Examine structures and interfaces between structures, when accessible, for signs of building settlement and/or differential settlement in accordance with IN 97-11 and 98-26. The settlement needs to be monitored. Add IN 97-11 and 98-26 to the references.	Update or revise the AMP program element.
3.4: (NMP-1 plant audit) The GALL program element states that for concrete structures, parameters monitored include loss of material, cracking, increase in porosity and permeability, loss of foundation strength, and reduction in concrete anchor capacity due to local concrete degradation. It does not include water in-leakage, which appears to be a common problem due to groundwater penetration/leakage.	Include the following parameters for monitoring and inspection: For concrete structures: water in-leakage, spalling, cracking, delaminations, honeycombs, chemical leaching, peeling paint, and discoloration. Examples of degradation of structural steel: corrosion, peeling of paints, deformed beams and columns, loose or missing anchors and fasters, missing or degraded grout under base plate, and cracked welds; and, for structural bolting: cracking, corrosion, and loss of preload.	Update or revise the AMP program element.
4. Detection of Aging Effects		
Structures are monitored under this program using periodic visual inspection of each structure/aging effect combination by a qualified inspector to ensure that aging degradation will be detected and quantified before there is loss of intended function. Visual inspection of		

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high strength (actual measured yield strength ≥ 150 ksi or 1,034 MPa) structural bolting greater than 1 inch (25 mm) in diameter is supplemented with volumetric or surface examinations to detect cracking. Other structural bolting (ASTM A-325, ASTM F1852, and ASTM A490 bolts) and anchor bolts are monitored for loss of material, loose or missing nuts, and cracking of concrete around the anchor bolts. Accessible sliding surfaces are monitored for indication of significant loss of material due to wear or corrosion, debris, or dirt. Visual inspection of elastomeric vibration isolation elements should be supplemented by feel to detect hardening if the vibration isolation function is suspect. The inspection frequency depends on safety significance and the condition of the structure as specified in NRC RG 1.160, Rev. 2. In general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. Some structures of lower safety significance, and subjected to benign environmental conditions, may be monitored at an interval exceeding five years; however, they should be identified and listed, together with their operating experience. The program includes provisions for more frequent inspections of structures and components categorized as (a)(1) in accordance with 10 CFR 50.65. Inspector qualifications should be consistent with industry guidelines and standards and guidelines for implementing the requirements of 10 CFR 50.65. Qualifications of inspection and evaluation personnel specified in ACI 349.3R are acceptable for license renewal. The structures monitoring program addresses detection of aging affects for inaccessible, below-grade concrete structural elements. For plants with non-aggressive ground water/soil (pH > 5.5, chlorides < 500 ppm, or sulfates <1500 ppm), the program recommends: (a) evaluating 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 and (b) examining representative samples of the exposed portions of the below grade concrete, when excavated for any reason. For plants with aggressive ground water/soil (pH < 5.5, chlorides > 500 ppm, or sulfates > 1500 ppm) and/or where the concrete structural elements have experienced degradation, a plant-specific AMP accounting for the extent of the degradation experienced should be implemented to manage the concrete aging during the period of extended operation.		
4.1: (NMP-1 plant audit) The GALL states that groundwater quality is monitored on a frequency not to exceed 5 years. The 5-year interval may not be adequate, considering seasonal variation and winter salting, to ensure that a benign environment is maintained. NRC IE Bulletin 80-10 requires the licensee with an operating license to establish a routine sampling/analysis or monitoring program for these systems in order to promptly identify any contaminating events that could lead to unmonitored, uncontrolled liquid or gaseous releases to the environment, including releases to onsite leaching fields or retention ponds. In response to NRC IE Bulletin 80-10,	Most plants have groundwater wells in place and are monitoring groundwater quality frequently in response to NRC IEB 80-10 NMP-1 samples groundwater quality at least every 6 months. It is recommended to change the interval of groundwater sampling from “not to exceed 5 years” to “not to exceed 6 months.” This is consistent with NMP-1 practice and would detect groundwater variation due to seasonal variation and winter salting to ensure that a benign environment is maintained.	Update or revise the AMP program element for a shorter interval of groundwater sampling.

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NMP-1 has nine wells and sampling of groundwater quality is scheduled every 6 months. Based on NRC IE Bulletin 80-10, routine sampling/analysis of groundwater conditions are performed in NMP-1 on groundwater wells to identify any radioactive contamination in the groundwater. The groundwater is sampled at least once every 6 months for corrosive indicators. NMP-1 SER Sec. 3.0.3.2.21 (Structures Monitoring Program) stated that the program is enhanced by regularly scheduled groundwater monitoring to ensure that a benign environment is maintained. NMP-1 performs groundwater monitoring at least once every 6 months, which is a strength of the NMP-1 AMP.		
4.1: (NMP-1 plant audit) SER Sec. 3.0.3.2.21 (Structures Monitoring Program) states that the program provides for visual inspections and surveys, and examination of all building and structures within the scope of license renewal. The GALL AMP does not include surveys in detection of aging effects.	Include surveys as an additional method to detect aging effects. This needs to explore the scope of surveys, parameters for monitoring, methods and frequency of survey, acceptance criteria, and corrective actions if acceptance criteria are not met. Examples of surveys may include displacements of sliding surfaces, and seismic gaps between buildings.	Update or revise the AMP program element to include surveys to detect aging effects.
4.2: The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Include detection of aging effects due to DEF in the AMPs.	Revise or update the AMP program element.
4.3: (NMP-1 plant audit) The GALL program element recommends periodic inspection of each structure/aging effect combination by a qualified inspector. However, it does not provide guidance on interval of the inspection. NMP-1 PBD has detailed inspection intervals that depend on the function of the SCCs. It can be considered a strength of the NMP-1 AMP.	Adapt the inspection intervals in the NMP-1 AMP, including the following: For SSCs with no degradation or defects identified in the baseline inspection, inspection should not exceed 24 months.	Revise or update the AMP program element.

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	For SSCs with evidence of degradation requiring corrective actions, or that may require future restoration, an appropriate monitoring frequency should be established based on function and degraded conditions of the SSCs. For degradation not requiring corrective actions, the conditions of the degraded areas should be monitored at each refueling cycle for a period of at least three cycles.	
4.4: (NMP-1 plant audit) The NMP-1 AMP requires that following an unusual event such as earthquake, tornado, or flooding, an initial inspection should be conducted to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment. This is considered a strength of the NMP-1 AMP.	It is recommended in the GALL that an initial inspection should be conducted after an unusual event such as earthquake, tornado, or flooding, to assess conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment.	Revise or update the AMP program element.
4.5: (NMP-1 plant audit) The GALL states that "Qualifications of inspection and evaluation personnel specified in ACI 349.3R are acceptable for license renewal." The NMP-1 Audit Report states that: a. The structures monitoring program implementing procedure has personnel qualification requirements that are different from the ones in the ACI 349.3R. During the interview, the licensee stated that the requirements are comparable, and GALL recommendations are not mandatory.	The GALL statement should be changed to the following: "Qualifications of inspection and evaluation personnel specified in ACI 349.3R or qualifications equivalent to the requirements specified in the ACI 349.3R are acceptable for license renewal."	Revise or update the AMP program element.
4.6: (NMP-1 plant audit) The NMP-1 Audit Report states that: b. The licensee does not maintain and continuously update the baseline data of the inspections previously. The	The need to include maintaining and continuously updating the baseline data of the inspections previously in the GALL program element should be investigated.	Revise or update the AMP program element.

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licensee stated that the inspectors review previous CRs of two previous outages before walkdowns to identify any specific areas of concern.		
4.7: (NMP-1 plant audit) The NMP-1 Audit Report states that: e. The implementing procedure states that that submerged structures such as intake tunnel to be inspected if possible. This is vague. The tunnels for the essential water systems run all the time and cannot be emptied out. Previously, the licensee sent divers to inspect the tunnel that identified minor cracking in the tunnels. Now the licensee is planning to use small remotely operated submarine type vehicle to inspect the tunnel. If this is successful, this procedure will be very useful at other plants that have the same issues. The NMP-1 Audit Report also states that: "One approach being considered by the licensee of using a remotely operated small submarine for inspection of underwater structures may be useful for other plants and applications. Suggest a follow-up with NMP-1 later to find out how successfully it was implemented and lessons learned."	Follow-up with NMP-1 later to find out how successful implementation was, and what lessons were learned that could provide guidance on inspections of intake tunnels and other water systems in GALL.	Revise or update the AMP program element.
4.8: (NMP-1 plant audit) The GALL states that: "In general, all structures and groundwater quality are monitored on a frequency not to exceed 5 years." The NMP-1 Audit Report states that: The licensee monitors ground water for chemical substances every 6 months. The analysis results do not include pH value. This may not be exactly consistent with Commitment 26. Previous tests indicate chlorides greater than 500, sulfate greater than 1500, and pH less than 5.5 in some wells. The licensee stated that this localized.	Based on the NMP-1 Audit Report, groundwater quality monitored on a frequency not to exceed 5 years apparently is adequate, as NMP-1 monitors ground water for chemical substances every 6 months. Intervals between groundwater quality monitoring should not exceed 6 months, because winter salting and seasonal variations may affect groundwater chemistry.	Revise or update the AMP program element.

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5. Monitoring and Trending		
Regulatory Position 1.5, "Monitoring of Structures," in NRC RG 1.160, Rev. 2, provides an acceptable basis for meeting the attribute. A structure is monitored in accordance with 10 CFR 50.65(a)(2) provided there is no significant degradation of the structure. A structure is monitored in accordance with 10 CFR 50.65(a)(1) if the extent of degradation is such that the structure may not meet its design basis or, if allowed to continue uncorrected until the next normally scheduled assessment, may not meet its design basis.		
5.1: (NMP-1 plant audit) Groundwater penetration/leakage could be a severe problem as plants get older. The amount of water leakage can be a parameter for trending.	Trend the amount of water leaked (in, e.g., gallons per day) due to groundwater penetration/leakage.	Update the AMP program element.
5.2: (NMP-1 plant audit) NMP-1 appears to have no trending report on a regular basis. The importance of performing trending on a regular basis should be stressed.	Change the program element name from “Monitoring and Trending” to “Trending” to emphasize important of trending on a regular basis (e.g., provide a trending report every 6 months).	Update or revise the AMP program element.
5.3: (NMP-1 plant audit) The NMP-1 Audit Report records “Persistent groundwater leakage in some structures. These structures are visually inspected and monitored for degradation.”	Groundwater leakage, as in the Seabrook plant, appears to be a common problem in structures and tunnels. Guidance should be provided on management of groundwater leakage in structures and tunnels.	Update or revise the AMP program element.
6. Acceptance Criteria		
The structures monitoring program calls for inspection results to be evaluated by qualified engineering personnel based on acceptance criteria selected for each structure/aging effect to ensure that the need for corrective actions is identified before loss of intended functions. The criteria are derived from design bases codes and standards that include ACI 349.3R, ACI 318, ANSI/ASCE 11, or the relevant AISC specifications, as applicable, and consider industry and plant operating experience. The criteria are directed at the identification and evaluation of degradation that may affect the ability of the structure or component to perform its intended function. Applicants who are not committed to ACI 349.3R and elect to use plant-specific criteria for concrete structures should describe the criteria and provide a technical basis for deviations from those in ACI 349.3R. Loose bolts and nuts and cracked high strength bolts are not acceptable unless accepted by engineering evaluation. Structural sealants are acceptable if the observed loss of material, cracking, and hardening will not result is loss of sealing. Elastomeric vibration isolation elements are acceptable if there is no loss of material, cracking, or hardening that could lead to the reduction or loss of isolation function. Acceptance criteria for sliding surfaces are (a) no indications of excessive loss of material due to corrosion or wear and (b) no debris or dirt that could restrict or prevent sliding of the surfaces as required by design. The structures monitoring program is to contain sufficient detail on acceptance criteria to conclude that this program attribute is satisfied.		
6.1: No acceptance criteria provided for groundwater quality	Provide acceptance criteria for groundwater quality such as the following: “If chloride, sulfate, or pH levels exceed an	Update the AMP program

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	established maximum allowable changes threshold, condition report and evaluation should be initiated."	element.
6.2: (NMP-1 plant audit) The NMP-1 Audit Report states that: The walkdown checklist does not contain any specific quantitative criteria in accordance with AC 349.3R. GALL, Rev. 2, states that applicants that are not committed to ACI 349.3R and elect to use plant-specific criteria for concrete structures should describe the criteria and technical basis for deviation from those in ACI 349.3R.	Investigate and add quantitative acceptance criteria such as allowable concrete crack widths based on ACI codes in GALL. For applicants that are not committed to ACI 349.3R and elect to use plant-specific criteria for concrete structures, the quantitative acceptance criteria of concrete crack width should also be described.	Update the AMP program element.
7. Corrective Actions		
Evaluations are performed for any inspection results that do not satisfy established criteria. Corrective actions are initiated in accordance with the corrective action process if the evaluation results indicate there is a need for a repair or replacement. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
IWA-1400 specifies the preparation of plans, schedules, and inservice inspection summary reports. In addition, written examination instructions and procedures, verification of qualification level of personnel who perform the examinations, and documentation of a quality assurance program are specified. IWA-6000 specifically covers the preparation, submittal, and retention of records and reports. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Although in many plants, structures monitoring programs have only recently been implemented, plant maintenance has been ongoing		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
since initial plant operations. NUREG-1522 documents the results of a survey sponsored in 1992 by the Office of Nuclear Regulatory Regulation to obtain information on the types of distress in the concrete and steel structures and components, the type of repairs performed, and the durability of the repairs. Licensees who responded to the survey reported cracking, scaling, and leaching of concrete structures. The degradation was attributed to drying shrinkage, freeze-thaw, and abrasion. The NUREG also describes the results of NRC staff inspections at six plants. The staff observed concrete degradation, corrosion of component support members and anchor bolts, cracks and other deterioration of masonry walls, and ground water leakage and seepage into underground structures. The observed and reported degradations were more severe at coastal plants than those observed in inland plants as a result of brackish and sea water. Previous license renewal applicants reported similar degradation and corrective actions taken through their structures monitoring program. Many license renewal applicants have found it necessary to enhance their structures monitoring program to ensure that the aging effects of structures and components in the scope of 10 CFR Part 54.4 are adequately managed during the period of extended operation. There is reasonable assurance that implementation of the structures monitoring program described above will be effective in managing the aging of the in-scope structures and component supports through the period of extended operation.		
10.1: (NMP-1 plant audit) The operating experience provided in this section is outdated. It does not contain enough operating experience in recent years like the cases below: 1. A NRC 2011 inspection report revealed that groundwater penetration to an underground electric tunnel at the Seabrook plant caused concrete to lose more than 20 percent of its strength. This degradation is due to sulfate attack that occurs when concrete is saturated in water. 2. NMP-1 Plant Operating Experience (SER 3.0.3.2.21): - There instances of minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels; - Several CRs have identified minor cracking in concrete structures, including the service water pipe tunnel, which is susceptible to small wall cracks that allow groundwater leakage; and - Groundwater has entered below-grade exterior walls of the switchgear building, service water tunnels, and the radwaste building.	This program element should be rewritten, and recent operating experience from the Seabrook plant and NMP-1 should be added. In addition, a literature search for additional cases of operating experience in the NRC database should be performed.	Update or revise the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
This operating experience indicates that groundwater penetration/leakage into structures is a severe problem and the structures monitoring appears ineffective in dealing with these problems.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.65, *Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,* Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 54.4, *Scope*, Office of the Federal Register, National Archives and Records Administration, 2009

ACI Standard 201.1R, *Guide for Making a Condition Survey of Concrete in Service,* American Concrete Institute, 1992.

ACI Standard 318, *Building Code Requirements for Reinforced Concrete and Commentary,* American Concrete Institute.

ACI Standard 349.3R, *Evaluation of Existing Nuclear Safety-Related Concrete Structures,* American Concrete Institute, 2002.

AISC, *AISC Specification for Steel Buildings,* American Institute of Steel Construction, Inc., Chicago, IL.

ANSI/ASCE 11-90, 99, *Guideline for Structural Condition Assessment of Existing Buildings,* American Society of Civil Engineers.

EPRI NP-5067, *Good Bolting Practices, A Reference Manual for Nuclear Power Plant Maintenance Personnel*, Volume 1: Large Bolt Manual, 1987; Volume 2: Small Bolts and Threaded Fasteners, Electric Power Research Institute, 1990.

EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volumes 1 and 2, Electric Power Research Institute, April 1988.

EPRI TR-104213, *Bolted Joint Maintenance & Application Guide,* Electric Power Research Institute, December 1995.

RCSC (Research Council on Structural Connections), *Specification for Structural Joints Using ASTM A325 or A490 Bolts,* Chicago, 2004.

NRC Regulatory Guide 1.127, Rev. 1, *Inspection of Water-Control Structures Associated with Nuclear Power Plants,* U.S. Nuclear Regulatory Commission, March 1978.

NRC Regulatory Guide 1.142, Rev. 2, *Safety-related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)*, U.S. Nuclear Regulatory Commission, November 2001.

NRC Regulatory Guide 1.160, Rev. 2, *Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,* U.S. Nuclear Regulatory Commission, March 1997.

NUMARC 93-01, Rev. 2, *Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants (Line-In/Line-Out Version),* Nuclear Energy Institute, April 1996.

NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, June 1990.

NUREG-1522, *Assessment of Inservice Condition of Safety-Related Nuclear Power Plant Structures,* June 1995.

A.46 XI.S7 RG 1.127, Inspection of Water-Cooled Structures Associated with Nuclear Power Plants

The verbatim text of GALL, Rev. 2, AMP XI.S7, RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.127, Revision 1, "Inspection of Water-Control Structures Associated with Nuclear Power Plants," describes an acceptable basis for developing an inservice inspection and surveillance program for dams, slopes, canals, and other raw water-control structures associated with emergency cooling water systems or flood protection of nuclear power plants. The NRC RG 1.127 program addresses age-related deterioration, degradation due to extreme environmental conditions, and the effects of natural phenomena that may affect water-control structures. The NRC RG 1.127 program recognizes the importance of periodic monitoring and maintenance of water-control structures so that the consequences of age-related deterioration and degradation can be prevented or mitigated in a timely manner. NRC RG 1.127 provides detailed guidance for the licensee's inspection program for water-control structures, including guidance on engineering data compilation, inspection activities, technical evaluation, inspection frequency, and the content of inspection reports. NRC RG 1.127 delineates current NRC practice in evaluating inservice inspection programs for water-control structures. For plants not committed to NRC RG 1.127, Revision 1, aging management of water-control structures may be included in the “Structures Monitoring” (AMP XI.S6). Even if a plant is committed to NRC RG 1.127, Revision 1, aging management of certain structures and components may be included in the “Structures Monitoring” (AMP XI.S6). However, details pertaining to water-control structures, as described herein, are incorporated in AMP XI.S6 program attributes. NRC RG 1.127 attributes evaluated below do not include inspection of dams. For dam inspection and maintenance, programs under the regulatory jurisdiction of the Federal Energy Regulatory Commission (FERC) or the U.S. Army Corps of Engineers, continued through the period of extended operation, are adequate for the purpose of aging management. For programs not falling under the regulatory jurisdiction of FERC or the U.S. Army Corps of Engineers, the staff evaluates the effectiveness of the aging management program (AMP) based on compatibility to the common practices of the FERC and Corps programs.		
a.1: In view of the Fukushima event, flood protection walls and gates should be included in the AMP.	Flood protection walls and gates should be included in the AMP in addition to dams, slopes, and canals.	Update the program description.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
a.2: The GALL states that: For plants not committed to NRC RG 1.127, Rev. 1, aging management of water-control structures may be included in the "Structures Monitoring" (AMP XI.S6). Even if a plant is committed to NRC RG 1.127, Rev. 1, aging management of certain structures and components may be included in "Structures Monitoring" (AMP XI.S6). However, details pertaining to water-control structures, as described herein, are incorporated in AMP XI.S6 program attributes. It is not clear what structures and components can be included in the "Structures Monitoring AMP."	In view of the Fukushima event, including flood protection walls and gates in this AMP is recommended. For plants committed to Reg. Guide 1.127, all water-control structures and components should be included in this AMP, not the "Structures Monitoring AMP." This would simplify the AMPs and provide focus on flood-protection walls and gates and other flood-protection structures.	Update the program description.
a.3: (NMP-1 plant audit) Groundwater penetration/leakage occurs frequently in the plants. It could become a severe problem as plants get older. Examples of recent operating experience related to groundwater penetration/leakage include the following: 1. A NRC 2011 inspection report revealed that groundwater penetration to underground electric tunnel at the Seabrook plant caused concrete to lose more than 20 percent of its strength. This degradation is due to sulfate attack that occurs when concrete is saturated in water. 2. NMP-1 Plant Operating Experience (SER 3.0.3.2.21): - There are instances of minor cracking in various concrete structures and slight (but stable) groundwater leaks in some tunnels; - Several CRs have identified minor cracking in concrete structures, including the service water pipe tunnel, which is susceptible to small wall cracks that allow groundwater leakage. - Groundwater has entered below-grade exterior walls	Aging management should be addressed in dealing with groundwater penetration/leakage and guidelines should be provided using the lessons learned from the Seabrook plant and other operating experience. Aging management of structures due to groundwater penetration/leakage would be an important task in the Structures Monitoring Program. It would affect Scope of Program, Parameters Monitor/Inspected, Detection of Aging Effects, Acceptance Criteria, Corrective Actions, and OE.	Update or revise the program description to include management of groundwater leakage.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
of the switchgear building, service water tunnels, and the radwaste building. These operating experiences indicate that the Structures Monitoring AMP may need to be enhanced in dealing with groundwater penetration/leakage.		
Program Basis Documents and/or Supporting Documents		
RG 1.127, Rev. 1, dated March 1978, is currently under revision. Draft RG DG-1245, dated January 2011, contains the proposed Rev. 2 of RG 1.127.		
b.1: In the years since the last revision of RG 1.127, several changes have been made to dam safety laws and to the requirements imposed on safety programs. The Draft Guide DG-1245 reflects current NRC positions and expectations for ISI programs. It provides an excellent summary of the main causes of dam failures and suggests possible preventive measures.	Revise the AMP based on information contained RG 1.127, Rev. 2, when it is officially approved.	Update or revise the AMP program description.
Program Consistency and Commitments		
The AMP for both Ginna and NMP-1 is consistent with GALL, Rev. 0, AMP XI.S7 RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants.		
c.1: No further review item was identified.		
1. Scope of Program		
NRC RG 1.127 applies to raw water-control structures associated with emergency cooling water systems or flood protection of nuclear power plants. The water-control structures included in the RG 1.127 program are concrete structures, embankment structures, spillway structures and outlet works, reservoirs, cooling water channels and canals, and intake and discharge structures. The scope of the program also includes structural steel and structural bolting associated with water-control structures, steel or wood piles and sheeting required for the stability of embankments and channel slopes, and miscellaneous steel, such as sluice gates and trash racks.		
1.1: The GALL does not mention flood-protection walls and gates, which are essential water-controlled structures.	Flood protection walls and gates should be included in the scope.	Update or revise the program description.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1.2: Review of the topical report NUREG/CR-6927 "Primer on Durability of Nuclear Power Plant Reinforced Concrete Structures - A Review of Pertinent Factors" Feb. 2007 (Naus) indicates that a potential aging degradation mechanism, DEF, may occur for the concrete structures during LTO. This degradation is caused by excessive heat curing, which decomposes the ettringite in Portland cement during the hydration process. Subsequently, if the concrete is exposed to substantial amounts of water for extended periods, ettringite reforms, leading to volume expansion, and the destructive expansive forces crack the concrete. DEF was first reported in heat-cured railway ties in Germany in the early 1980s. Since then, several other countries, including the United States, have reported DEF problems in concrete structures (DOT News Letter, July 2004). The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate-to-aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment (Naus). The aging effects/mechanism due to DEF and the preventive measurements should be included in the AMPs.	Update or revise the AMP program element.
1.3: (Ginna plant audit) The NMP-1 plant basis document states that Ginna Structure Monitoring AMP includes buried concrete, embedded steel, and structural components blocked by installed equipment or structures. Ginna considered the following for its AMP in managing aging effects in inaccessible areas: f. When "serious degradation in inaccessible areas" is identified from other utility plant inspections that may be an area of concern for this plant; g. When indicators exist that degradation may be occurring in an inaccessible area; and h. When an event occurs that could affect an inaccessible	Recommend changes in GALL: 1. Spell out inaccessible areas in included embedded steel, and structural components blocked by installed equipment or structures. 2. Augment the program to include descriptions of the following: i. When "serious degradation in inaccessible areas" is identified from other utility plant inspections that may be an area of concern for this plant; and j. When an event occurs that could affect an inaccessible area, making it susceptible to degradation.	Update or revise the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
area making it susceptible to degradation.		
2. Preventive Actions		
NRC RG 1.127 is a condition-monitoring program. This program is augmented to incorporate preventive measures recommended in NUREG-1339, Electric Power Research Institute (EPRI) TR-104213, EPRI NP-5067, and EPRI NP-5769 to ensure structural bolting integrity, if applicable. The documents provide guidelines for selection of replacement bolting material, approved thread lubricants, and appropriate torque and preload to be used for installation of bolting. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and stress corrosion cracking potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication "Specification for Structural Joints Using ASTM A325 or A490 Bolts" need to be used.		
2.1: (NMP-1 plant audit) Groundwater penetration/leakage could be a severe problem as plants get older. The GALL could suggest preventive actions for stopping or mitigating groundwater penetration/leakage, such as painting of the structural surfaces.	Preventive actions for stopping or mitigating groundwater penetration/leakage should be provided.	Update or revise the AMP program element.
2.2: The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Prevention or minimization of DEF can be accomplished by lowering the curing temperature (<70°C), limiting clinker sulfate levels below 1.5%, avoiding excessive curing for potentially critical sulfate-to-aluminate ratios, preventing exposure to substantial water in service, and using proper air entrainment (Naus). The aging effects/mechanism due to DEF and the preventive measurements should be included in the AMPs.	Revise or update the AMP program element.
2.3: The proposed Revision 2 of RG 1.127 (i.e., Draft Guide DG-1245) reflects current NRC positions and expectations for ISI programs. It provides an excellent summary of the main causes of dam failures and suggests possible preventive measures.	Preventive measures should be added to Draft Guide DG-1245 for dam failures in the AMP.	Revise or update the AMP program element.
3. Parameters Monitored/Inspected		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
NRC RG 1.127 identifies the parameters to be monitored and inspected for water-control structures. The parameters vary depending on the particular structure. Parameters to be monitored and inspected for concrete structures are those described in American Concrete Institute (ACI) 201.1 and ACI-349-3R. These include cracking, movements (e.g., settlement, heaving, deflection), conditions at junctions with abutments and embankments, loss of material, increase in porosity and permeability, seepage, and leakage. Parameters to be monitored and inspected for earthen embankment structures include settlement, depressions, sink holes, slope stability (e.g., irregularities in alignment and variances from originally constructed slopes), seepage, proper functioning of drainage systems, and degradation of slope protection features. Steel components are monitored for loss of material due to corrosion. Parameters monitored for channels and canals include erosion or degradations that may impose constraints on the function of the cooling system and present a potential hazard to the safety of the plant. Submerged emergency canals (e.g., artificially dredged canals at the river bed or the bottom of the reservoir) should be monitored for sedimentation, debris, or instability of slopes that may impair the function of the canals under extreme low flow conditions. Further details of parameters to be monitored and inspected for these and other water-control structures are specified in Section C.2 of NRC RG 1.127. The program is augmented to require monitoring of bolted connections for loss of material and loose bolts and nuts and other conditions indicative of loss of preload. High strength (actual measured yield strength ≥ 150 ksi or 1,034 MPa) structural bolts greater than 1 inch (25 mm) in diameter are monitored for stress corrosion cracking, if applicable. Other structural bolting (ASTM A-325, ASTM F1852, and ASTM A490 bolts) and anchor bolts are monitored for loss of material, loose or missing nuts, and cracking of concrete around the anchor bolts. Accessible sliding surfaces are monitored for indication of significant loss of material due to wear or corrosion, debris, or dirt. The program also is augmented to require monitoring of wooden components for loss of material and change in material properties.		
3.1: The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Parameters monitored/inspected for DEF should be included in the AMPs.	Revise or update the AMP program element.
3.2: (NMP-1 plant audit) The GALL program element states that for concrete structures, parameters monitored include loss of material, cracking, increase in porosity and permeability, loss of foundation strength, and reduction in concrete anchor capacity due to local concrete degradation. It does not include water in-leakage, which appears to be a	Include the following parameters for monitoring and inspection: For concrete structures: water in-leakage, spalling, cracking, delaminations, honeycombs, chemical leaching, peeling paint, and discoloration.	Update or revise the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
common problem due to groundwater penetration/leakage.	Examples of degradation of structural steel: corrosion, peeling of paints, deformed beams and columns, loose or missing anchors and fasters, missing or degraded grout under base plate, cracked welds; and structural bolting: cracking, corrosion, and loss of preload.	
4. Detection of Aging Effects		
NRC RG 1.127 specifies that inspection of water-control structures should be conducted under the direction of qualified engineers experienced in the investigation, design, construction, and operation of these types of facilities. Visual inspections are primarily used to detect degradation of water-control structures. In some cases, instruments have been installed to measure the behavior of water-control structures. NRC RG 1.127 indicates that the available records and readings of installed instruments are to be reviewed to detect any unusual performance or distress that may be indicative of degradation. NRC RG 1.127 describes periodic inspections to be performed at least once every 5 years. This interval has been shown to be adequate to detect degradation of water-control structures before a loss of an intended function. The program should include provisions for increased inspection frequency if the extent of the degradation is such that the structure or component may not meet its design basis if allowed to continue uncorrected until the next normally scheduled inspection. NRC RG 1.127 also describes special inspections immediately following the occurrence of significant natural phenomena, such as large floods, earthquakes, hurricanes, tornadoes, and intense local rainfalls. The program should address detection of aging affects for inaccessible, below-grade, and submerged concrete structural elements. For plants with non-aggressive raw water and groundwater/soil (pH > 5.5, chlorides < 500 parts per million [ppm], or sulfates < 1500 ppm), the program should require (a) evaluation of 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 and (b) examination of representative samples of the exposed portions of the below-grade concrete when excavated for any reason. Submerged concrete structures should be inspected during periods of low tide or when dewatered and accessible. For plants with aggressive environment raw water (pH < 5.5, chlorides > 500 ppm, or sulfates > 1500 ppm) or ground water/soil and/or where the concrete structural elements have experienced degradation, a plant-specific AMP accounting for the extent of the degradation experienced should be implemented to manage the concrete aging during the period of extended operation.		
4.1: The combination of aging effect/mechanism due to DEF is not included in the AMPs of GALL, Rev. 2, related to concrete structures.	Detection of aging effects due to DEF should be included in the AMPs.	Revise or update the AMP program element.
4.2: (NMP-1 plant audit) The NMP-1 AMP requires that following an unusual event such as an earthquake, tornado, or flood, an initial inspection should be conducted to assess	The GALL should note that an initial inspection should be conducted after an unusual event such as earthquake, tornado, or flood, to assess conditions of the affected	Revise or update the AMP program

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
conditions of the affected SSCs. A complete structural inspection may be required, depending on the assessment. This is considered a strength of the NMP-1 AMP.	SSCs. A complete structural inspection may be required, depending on the assessment.	element.
5. Monitoring and Trending		
Water-control structures are monitored by periodic inspection, as described in NRC RG 1.127. Changes of degraded conditions from prior inspection, such as growth of an active crack or extent of corrosion, should be trended until it is evident that the change is no longer occurring or until corrective actions are implemented in accordance with 10 CFR 50.65 and RG 1.160, Rev. 2.		
5.1: (NMP-1 plant audit) Groundwater penetration/leakage could be a severe problem as plants get older. The amount of water leakage can be a parameter for trending.	Trend the amount of water leaked (in, e.g., gallons per day) due to groundwater penetration/leakage.	Update or revise the AMP program element.
5.2: (NMP-1 plant audit) NMP-1 appears to have no trending report on a regular basis. It is important to perform trending on a regular basis.	Change the program element name from "Monitoring and Trending" to "Trending" to emphasize importance of trending on regular basis (e.g., providing a trending report every 6 months).	Update or revise the AMP program element.
6. Acceptance Criteria		
Quantitative acceptance criteria to evaluate the need for corrective actions are not specified in NRC RG 1.127. However, the "Evaluation Criteria" provided in Chapter 5 of ACI 349.3R provide acceptance criteria (including quantitative criteria) for determining the adequacy of observed aging effects and specifies criteria for further evaluation. Although not required, plant-specific acceptance criteria based on Chapter 5 of ACI 349.3R are acceptable. Acceptance criteria for earthen structures, such as canals and embankments, are consistent with programs falling within the regulatory jurisdiction of the FERC or the U.S. Army Corps of Engineers. Loose bolts and nuts, cracked high strength bolts, and degradation of piles and sheeting are accepted by engineering evaluation or subject to corrective actions. Engineering evaluation should be documented and based on codes, specifications, and standards such as AISC specifications, SEI/ASCE 11, and those referenced in the plant's current licensing basis.		
7. Corrective Actions		
NRC RG 1.127 recommends that when inspection findings indicate that significant changes have occurred, the conditions are to be evaluated. This includes a technical assessment of the causes of distress or abnormal conditions, an evaluation of the behavior or movement of the structure, and recommendations for remedial or mitigating measures. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
Degradation of water-control structures has been detected, through NRC RG 1.127 programs, at a number of nuclear power plants, and, in some cases, it has required remedial action. NRC NUREG-1522 described instances and corrective actions of severely degraded steel and concrete components at the intake structure and pump-house of coastal plants. Other degradation described in the NUREG include appreciable leakage from the spillway gates, concrete cracking, corrosion of spillway bridge beam seats of a plant dam and cooling canal, and appreciable differential settlement of the outfall structure of another. No loss of intended functions has resulted from these occurrences. Therefore, it can be concluded that the inspections implemented in accordance with the guidance in NRC RG 1.127 have been successful in detecting significant degradation before loss of intended function occurs.		
10.1: Appendix B of the Draft RG DG-1245 contains list of dam failures that are not mentioned in the GALL.	Add cases of dam failures based on Appendix B of the Draft RG DG-1245.	Update or revise the AMP program element.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ACI Standard 201.1R, *Guide for Making a Condition Survey of Concrete in Service,* American Concrete Institute, 1992.

ACI Standard 349.3R, *Evaluation of Existing Nuclear Safety-Related Concrete Structures,* American Concrete Institute, 2002.

EPRI NP-5067, *Good Bolting Practices, A Reference Manual for Nuclear Power Plant Maintenance Personnel*, Volume 1: Large Bolt Manual, 1987; Volume 2: Small Bolts and Threaded Fasteners, Electric Power Research Institute, 1990.

EPRI NP-5769, *Degradation and Failure of Bolting in Nuclear Power Plants*, Volumes 1 and 2, Electric Power Research Institute, April 1988.

EPRI TR-104213, *Bolted Joint Maintenance & Application Guide,* Electric Power Research Institute, December 1995.

NRC Regulatory Guide 1.127, *Inspection of Water-Control Structures Associated with Nuclear Power Plants,* Revision 1, U.S. Nuclear Regulatory Commission, March 1978.

NRC Regulatory Guide 1.160, Rev. 2, *Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,* U.S. Nuclear Regulatory Commission, March 1997.

NUREG-1339, *Resolution of Generic Safety Issue 29: Bolting Degradation or Failure in Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, June 1990.

NUREG-1522, *Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures*, U.S. Nuclear Regulatory Commission, June 1995.

RCSC (Research Council on Structural Connections), *Specification for Structural Joints Using ASTM A325 or A490 Bolts,* 2004.

A.47 XI.S8 Protective Coating Monitoring and Maintenance Program

The verbatim text of GALL, Rev. 2, AMP XI.S8, Protective Coatings, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
Proper maintenance of protective coatings inside containment (defined as Service Level I in Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.54, Rev. 1, or latest version) is essential to ensure operability of post-accident safety systems that rely on water recycled through the containment sump/drain system. Degradation of coatings can lead to clogging of Emergency Core Cooling Systems (ECCS) suction strainers, which reduces flow through the system and could cause unacceptable head loss for the pumps. Maintenance of Service Level I coatings applied to carbon steel and concrete surfaces inside containment (e.g., steel liner, steel containment shell, structural steel, supports, penetrations, and concrete walls and floors) also serve to prevent or minimize loss of material due to corrosion of carbon steel components and aids in decontamination. Regulatory Position C4 in NRC RG 1.54, Rev. 2, describes an acceptable technical basis for a Service Level I coatings monitoring and maintenance program that can be credited for managing the effects of corrosion for carbon steel elements inside containment. American Society for Testing of Materials (ASTM) D 5163-08 and endorsed years of the standard in NRC RG 1.54 are acceptable and considered consistent with NUREG-1801. In addition, Electric Power Research Institute (EPRI) Report 1019157, Guidelines for Inspection and Maintenance of Safety-related Protective Coatings, provides additional information on the ASTM standard guidelines. A comparable program for monitoring and maintaining protective coatings inside containment, developed in accordance with NRC RG 1.54, Rev. 2, is acceptable as an aging management program for license renewal. Service Level I coatings credited for preventing corrosion of steel containments and steel liners for concrete containments are subject to requirements specified by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, Subsection IWE (AMP XI.S1). However, this program (AMP XI.S8) reviews Service Level I coatings to ensure that the protective coating monitoring and maintenance program are adequate for license renewal.		
a.1: (Ginna plant visit) The GALL, Rev. 2, XI.S8 program only addresses maintenance of protective coating inside containment (SL 1). The Ginna interviewees suggested including SL-III (Safety Related Coatings Outside of	Expand the program description to Include SL-III (Safety Related Coatings Outside of Containment) in the scope of the AMP.	Revise or update the program description.

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Containment). Although tracking of SL-III coatings is not required by regulations, I0 CFR 50, Appendix B, Criterion 11, "Design Control," and Criterion IX, "Special Processes," do apply to the application and inspection process. 10 CFR 50, Appendix B, requires personnel who perform protective coatings work for Service Level III to be appropriately qualified, and that the coatings used be procured and controlled for safety-related use.		
Program Basis Documents and/or Supporting Documents		
NRC GSI-191 discusses the clogging of containment emergency sumps and is an open generic safety issue.		
b.1: The AMP addresses the concerns in NRC GSI-191, which discusses the clogging of containment emergency sumps and is an open generic safety issue. However, it does not explicitly cite GSI-191	It would be helpful to cite GSI-191 in the program description.	Revise or update the program description.
b.2: (Ginna Plant Audit) Ginna interviewees suggested careful updating including (but not limited to) the following: ASTM D7230-06—Standard Guide for Evaluating Polymeric Lining Systems for Water Immersion in Coating Service Level III Safety-Related Applications on Metal Substrates, July 1, 2006.	Extract relevant material from ASTM D7230-06—Standard Guide for Evaluating Polymeric Lining Systems for Water Immersion in Coating Service Level III Safety-Related Applications on Metal Substrates and include them in the AMP. Also, the GALL AMP should also consider adding ASTM D7167-05 "Standard Guide for Establishing Procedures to Monitor the Performance of Safety-Related Coating Service Level III Lining Systems in an Operating Nuclear Power Plant."	Revise or update the AMP to include these documents.
Program Consistency and Commitments		
Ginna: There were no explicit commitments in the SER, Appendix A, related to the protective coating program (PCP). However, there is overlap between the earlier PCP and the Systems Monitoring Program. The Ginna 71003 Phase II report discussed follow up on Commitment No. 14 that specified that the licensee would enhance Systems Monitoring Program to include all systems within the scope of license renewal and provide additional guidance for detecting aging effects prior to June 2004. The Systems Monitoring Program was an existing program that contained guidelines for system engineers to assess the material condition of SSCs during their periodic system		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
walkdowns and was enhanced to include additional systems and specific guidance for managing aging effects such as loss of material, cracking, and fouling. The inspectors performed a visual inspection of external surfaces for leakage and evidence of material degradation such as corrosion, cracking, coating or sealant degradation, deformation, and debris or corrosion product buildup. Based on review of the timeliness and adequacy of the licensee's actions, the inspectors determined that the licensee met Commitment 14. NMP-1 has the following commitments in the SER, Appendix A, prior to the PEO: (1) Visually examine coated surfaces for any visible defects including blistering, cracking, flaking, peeling, and physical or mechanical damage. (2) Perform periodic inspection of coatings every refueling outage versus every 24 months. (3) Set minimum qualifications for inspection personnel, the inspection coordinator, and inspection results evaluators. (4) Perform thorough visual inspections in areas noted to be deficient concurrently with general visual inspections. (5) Specify the types of instruments and equipment that may be used for inspections. (6) Conduct pre-inspection reviews of the previous two monitoring reports before performing the condition assessment. (7) Establish guidelines for prioritization of repair areas and monitoring these areas until they are repaired. (8) Require that the inspection results evaluator determine which areas are unacceptable, and initiate corrective action. These details are contained in ASTM D5163-08, and are discussed in GALL Rev. 2 under the respective program elements.		
c.1: No further review item was identified.		
1. Scope of Program		
The minimum scope of the program is Service Level I coatings applied to steel and concrete surfaces inside containment (e.g., steel liner, steel containment shell, structural steel, supports, penetrations, and concrete walls and floors), defined in NRC RG 1.54, Rev. 2, as follows: "Service Level I coatings are used in areas inside the reactor containment where the coating failure could adversely affect the operation of post-accident fluid systems and thereby impair safe shutdown." The scope of the program also should include any Service Level I coatings that are credited by the licensee for preventing loss of material due to corrosion in accordance with AMP XI.S1.		
1.1: (Ginna plant visit) Ginna interviewees suggested inclusion of both SL-I coatings and SL-III coatings. As stated in Rev. 2 of RG 1.54, Service Level III coatings are used in areas outside the reactor containment where failure could adversely affect the safety function of a safety-related SSC.	Expand the scope of program to Include SL-III (Safety Related Coatings Outside of Containment) in the scope of the AMP.	Revise or update the program element.
2. Preventive Actions		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The program is a condition monitoring program and does not recommend any preventive actions. However, for plants that credit coatings to minimize loss of material, this program is a preventive action.		
2.1: No further review item was identified.		
3. Parameters Monitored/Inspected		
Regulatory Position C4 in NRC RG 1.54, Rev 1, states, "ASTM D 5163-96 provides guidelines that are acceptable to the NRC staff for establishing an in-service coatings monitoring program for Service Level I coating systems in operating nuclear power plants..." However, ASTM D 5163-96 has been superseded by ASTM D 5163-08. ASTM D 5163-08 identifies the parameters monitored or inspected to be "any visible defects, such as blistering, cracking, flaking, peeling, rusting, and physical damage."		
3.1: No further review item was identified.		
4. Detection of Aging Effects		
ASTM D 5163-08, paragraph 6, defines the inspection frequency to be each refueling outage or during other major maintenance outages, as needed. ASTM D 5163-08, paragraph 9, discusses the qualifications for inspection personnel, the inspection coordinator, and the inspection results evaluator. ASTM D 5163-08, subparagraph 10.1, discusses development of the inspection plan and the inspection methods to be used. It states that a general visual inspection shall be conducted on all readily accessible coated surfaces during a walk-through. After a walk-through, or during the general visual inspection, thorough visual inspections shall be carried out on previously designated areas and on areas noted as deficient during the walk-through. A thorough visual inspection shall also be carried out on all coatings near sumps or screens associated with the Emergency Core Cooling System (ECCS). This subparagraph also addresses field documentation of inspection results.		
4.1: (Ginna Plant Audit) In 2006, NRC carefully reviewed the EPU effect on protective coating systems (per the NRR SG & ChemEng Branch input to Section 2.1.7 of the SE) and concluded that Ginna appropriately addressed the impact of changes in conditions following a design-basis loss of coolant accident (LOCA) and their effects on these organic materials. The NRC staff further concluded that the licensee has demonstrated that conditions following the implementation of the proposed EPU (in terms of containment temperature, pressure, pH and radiation dose) will continue to be bounded by qualification test conditions. Therefore, the NRC staff finds the proposed EPU acceptable with respect to protective coating systems and	The EPU effects (e. g., containment temperature, pressure, pH, and radiation dose) should be taken into consideration to ensure the qualification test methods used in the AMP are effective in detecting aging effects of containment protective coatings.	Revise or update the program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
other organic materials.		
5. Monitoring and Trending		
ASTM D 5163-08 identifies monitoring and trending activities in subparagraph 7.2, which specifies a pre-inspection review of the previous two monitoring reports, and in subparagraph 11.1.2, which specifies that the inspection report should prioritize repair areas as either needing repair during the same outage or as postponed to future outages, but under surveillance in the interim period.		
5.1: (Ginna and NMP-1 plant audits) The GALL program element does not provide guidance on trending. In the current methodology used at Ginna and NMP-1, the total amount of degraded coating in the containment is compared with the total amount of permitted degraded coatings to ensure post-accident operability of the ECCS suction strainers. For example, based on Ginna 2009 inspection results, the total degraded coatings are 223 sq. ft.	The total amount of degraded coatings in the containments should be trended to ensure that degraded coatings are trending down.	Revise or update the AMP program element.
6. Acceptance Criteria		
ASTM D 5163-08, subparagraphs 10.2.1 through 10.2.6, 10.3, and 10.4, contains one acceptable method for the characterization, documentation, and testing of defective or deficient coating surfaces. Additional ASTM and other recognized test methods are available for use in characterizing the severity of observed defects and deficiencies. The evaluation covers blistering, cracking, flaking, peeling, delamination, and rusting. ASTM D 5163-08, paragraph 11, addresses evaluation. It specifies that the inspection report is to be evaluated by the responsible evaluation personnel, who prepare a summary of findings and recommendations for future surveillance or repair, and prioritization of repairs.		
6.1: No further review item was identified.		
7. Corrective Actions		
A recommended corrective action plan is required for major defective areas so that these areas can be repaired during the same outage, if appropriate. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
NRC Information Notice 88-82, NRC Bulletin 96-03, NRC Generic Letter (GL) 04-02, and NRC GL 98-04 describe industry experience pertaining to coatings degradation inside containment and the consequential clogging of sump strainers. NRC RG 1.54, Rev. 1, was issued in July 2000. Monitoring and maintenance of Service Level I coatings conducted in accordance with Regulatory Position C4 is expected to be an effective program for managing degradation of Service Level I coatings and, consequently, an effective means to manage loss of material due to corrosion of carbon steel structural elements inside containment.		
10.1: No further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASTM D 5163-05, *Guide for Establishing Procedures to Monitor the Performance of Coating Service Level I Coating Systems in an Operating Nuclear Power Plant,* American Society for Testing and Materials, 2005.

ASTM D 5163-08, *Standard Guide for Establishing a Program for Condition Assessment of Coating Service Level I Coating Systems in Nuclear Power Plants,* American Society for Testing and Materials, 2008.

ASTM D 5163-96, *Standard Guide for Establishing Procedures to Monitor the Performance of Safety Related Coatings in an Operating Nuclear Power Plant,* American Society for Testing and Materials, 1996.

EPRI Report 1003102, *Guideline on Nuclear Safety-Related Coatings*, Revision 1, (Formerly TR-109937), Electric Power Research Institute, November 2001.

EPRI Report 1019157, *Guideline on Nuclear Safety-Related Coatings*, Revision 2, (Formerly TR-109937and 1003102), Electric Power Research Institute, December 2009.

NRC Bulletin 96-03, *Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors*, U.S. Nuclear Regulatory Commission, May 6, 1996.

NRC Generic Letter 98-04, *Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-Of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment,* U.S. Nuclear Regulatory Commission, July 14, 1998.

NRC Generic Letter 04-02, *Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors*, U.S. Nuclear Regulatory Commission, September 13, 2004.

NRC Information Notice 88-82, *Torus Shells with Corrosion and Degraded Coatings in BWR Containments*, U.S. Nuclear Regulatory Commission, November 14, 1988.

NRC Information Notice 97-13, *Deficient Conditions Associated With Protective Coatings at Nuclear Power Plants*, U.S. Nuclear Regulatory Commission, March 24, 1997.

NRC Regulatory Guide 1.54, Rev. 0, *Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants,* U.S. Nuclear Regulatory Commission, June 1973.

A.48 X.S1 Concrete Containment Tendon Prestress

The verbatim text of GALL, Rev. 2, AMP for X.S1, Concrete Containment Tendon Prestress, for managing TLAAs, is included in the following worksheet; all blue text is directly transcribed. The information source for line items based on visits to Ginna and NMP-1 plants is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
This aging management program provides reasonable assurance of the adequacy of prestressing forces in prestressed concrete containment tendons during the period of extended operation under 10 CFR 54.21(c)(1)(iii). The program consists of an assessment of inspections performed in accordance with the requirements of Subsection IWL of the American Society of Mechanical Engineers (ASME) Code, Section XI, as supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii). The assessment related to the adequacy of the prestressing force establishes (a) acceptance criteria in accordance with U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.35.1 and (b) trend lines based on the guidance provided in NRC Information Notice (IN) 99-10. As evaluated below, this time-limited aging analysis (TLAA) is an acceptable option to manage containment tendon prestress forces. However, it is recommended that the staff further evaluate an applicant's operating experience related to the containment tendon prestress force. Programs related to the adequacy of prestressing force for containments with grouted tendons are reviewed on a case-by-case basis.		
a.1: The GALL does not mention the reasons (aging mechanisms) for loss of tendon prestress**.**	Loss of prestress can be due to relaxation, shrinkage, creep, and elevated temperature.	Update the program element.
Program Basis Documents and/or Supporting Documents		
Subsection IWL of the American Society of Mechanical Engineers (ASME) Code, Section XI supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii), NRC Regulatory Guide (RG) 1.35.1 and NRC Information Notice (IN) 99-10.		
Program Consistency and Commitments		
Ginna has two commitments in the Appendix A of the SER: (1) Retension 23 containment tendons as part of the 2005 tendon testing tendon program. (2) Perform two structural integrity tests at design pressure during the PEO (item 27).		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
c.1: (Ginna plant audit) On the second commitment, the Ginna SER NUREG 1786 states: In its evaluation of the applicant's response to RAI B2.1.3-2, the staff recognized that the applicant is aggressive in performing tendon inspections, and that the tendon inspections provide a certain degree of confidence regarding the integrity of the rock anchor system coupled to the tendons. However, it is for the other inaccessible features of the containment that the staff needs additional assurance for the period of extended operation. Inspections performed in accordance with the requirements of Subsection IWL of Section XI of the ASME Code will not be able to detect problems with the (1) tendon bellows, (2) elastomer pads, and (3) radial tension bars. Moreover, the areas of the containment where these components are located are below the ground water level, and the staff had identified water-related problems around the elastomer pads in the early 1990s. The applicant needs to develop an AMP (or periodic functional tests) that would verify the containment functionality at the location of the containment support. In a subsequent discussion with the applicant, the staff suggested that the applicant perform two or three structural integrity tests (SITs) during the period of extended operation. An SIT could be performed at the peak calculated pressure that would demonstrate conformance with the expected behavior of the lower part of the containment. SIT measurements would consist of radial and vertical deformations, similar to the measurements taken during initial and subsequent SITs, and visual observations during and after the tests. The comparison will allow the applicant to detect significant deviation from the containment expected	The staff evaluation indicates that evaluation of the SIT results would indicate whether there was a gross change in the containment behavior that would indicate significant degradation of the inaccessible components. It is recommended that the SITs should be conducted in the subsequent license renewal. The water-related problems in Ginna prestressed containment and its effect on tendon bellows, elastomer pads (neoprene pad), and radial tendon bars should be investigated, because groundwater leakage appears to be a common problem in the below-grade structures and tunnels in many plants.	Update the program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
behavior. In a letter dated July 30, 2003, the applicant committed to perform two SITs during the period of extended operation, one in 2009 and one in 2029 (reference item 27 in Appendix A to this SER). The staff finds the commitment acceptable, as it would periodically verify the behavior of the containment in the lower portion of the containment. Evaluation of the test results would indicate if there is a gross change in the containment behavior which would indicate significant degradation of the inaccessible components.		
1. Scope of Program		
The program addresses the assessment of containment tendon prestressing force when an applicant performs the containment prestress force TLAA using 10 CFR 54.21(c)(1)(iii).		
2. Preventive Actions		
Maintaining the prestress above the minimum required value (MRV), as described under the acceptance criteria below, ensures that the structural and functional adequacy of the containment are maintained.		
2.1: (Ginna plant audit) The Ginna IWE Audit Report regarding future guidance states the folllowing: Recommend installation of strain gages on tendons like the ones installed at GINNA.	Installation of strain gages on tendons would detect loss of tendon prestress in a timely manner and prevent further loss of prestress. Installation of strain gages on tendons should be considered for SLR as a preventive action.	Update the program element.
2.2: (Ginna plant audit) The following statement appears in the Ginna SER (NUREG-1786): The TLAA for the evaluation of loss of prestress in containment tendons concluded that the initial retensioned set of 23 tendons should be retensioned prior to the end of the current licensing period to ensure that prestressing forces remain above the MRV during the period of extended operation.	Treating “Retension of the tendons experienced loss of prestress in the current license term prior to the end current license period” as a requirement is recommended for the subsequent license renewal.	Update the program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
(See Comment 10.3 in the Operating Experience program element.)		
3. Parameters Monitored/Inspected		
The parameters monitored are the containment tendon prestressing forces in accordance with requirements specified in Subsection IWL of Section XI of the ASME Code, as incorporated by reference in 10 CFR 50.55a.		
4. Detection of Aging Effects		
The loss of containment tendon prestressing forces is detected by the program.		
4.1: (Ginna plant audit) The GALL program element does not mention the reasons (aging mechanisms) for loss of tendon prestress	Change the GALL statement as follows: The loss of containment tendon prestressing forces due to relaxation, shrinkage, creep, and elevated temperature is detected by the program.	Update the program element.
4.2: (Ginna plant audit) The GALL program element does not mention the frequency of measurement of tendon prestress for detecting loss of prestress in a timely manner.	Add the required frequency in measuring the tendon prestress in accordance with the requirements of Subsection IWL of the American Society of Mechanical Engineers (ASME) Code, Section XI, as supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii).	Update the program element.
4.2: (Ginna plant audit) The Ginna SER states the following: Regulatory Guide 1.35 requires that at least 4% of the population of each tendon group be randomly sampled during each surveillance. The GALL program element does not contain sufficient information on detection of aging effects.	Add more details on detection of aging effects based on Regulatory Guide 1.35 and other documents (e.g., the requirement of at least 4% of the population of each tendon group should be randomly sampled during each surveillance).	Update the program element.
5. Monitoring and Trending		
The estimated and measured prestressing forces are plotted against time, and the predicted lower limit (PLL), MRV, and trending lines are developed for the period of extended operation. NRC RG 1.35.1 provides guidance for calculating PLL and MRV. The trend line represents the trend of prestressing forces based on the actual measured forces. NRC IN 99-10 provides guidance for constructing the trend line.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
6. Acceptance Criteria		
The prestressing force trend lines indicate that existing prestressing forces in the containment tendon would not be below the MRVs prior to the next scheduled inspection, as required by 10 CFR 50.55a(b)(2)(viii)(B). The acceptance criteria normally consists of PLL and the minimum required prestressing force, also called MRV. The goal is to keep the trend line above the PLL because, as a result of any inspection performed in accordance with ASME Section XI, Subsection IWL, if the trend line crosses the PLL, the existing prestress in the containment tendon could go below the MRV soon after the inspection and would not meet the requirements of 10 CFR 50.55a(b)(2)(viii)(B).		
7. Corrective Actions		
If acceptance criteria are not met, then either systematic retensioning of tendons or a reanalysis of the containment is warranted to ensure the design adequacy of the containment. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
8. Confirmation Process		
The confirmation process ensures that preventive actions are adequate and that appropriate corrective actions have been completed and are effective. The confirmation process for this program is implemented through the site's quality assurance (QA) program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
9. Administrative Controls		
The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.		
10. Operating Experience		
The program incorporates the relevant operating experience that has occurred at the applicant's plant as well as at other plants. The applicable portions of the experience with prestressing systems described in NRC IN 99-10 could be useful. Additional industry operating experience has been documented in NUREG/CR-4652 and in the May/June 1994 *Concrete International* publication by H. Ashar, C. P. Tan, and D. Naus. However, tendon operating experience may be different at plants with prestressed concrete containments. The difference could be due to the prestressing system design (e.g., button-headed, wedge, or swaged anchorages), environment, and type of reactor (i.e., pressurized water reactor and boiling water reactor). Thus, the applicant's plant-specific operating experience should be further evaluated for license renewal.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
10.1: (Ginna plant audit) The Ginna SER (NUREG-1786) states the following: (2) An increase in temperature from ambient conditions to operating conditions significantly increases the amount of stress relaxation over time. For example, at a temperature of 104 degrees F after 40 years, the stress relaxation in the tendon would be expected to be as high as 21%, as opposed to 12%, as originally predicted. This is useful information for operating experience.	Add the finding in the Ginna SER (NUREG-1786) to the GALL Operating Experience program element.	Update the AMP program element.
10.2: (Ginna audit plant) The GALL program element has provided a reference by Asher et al. on operating experience. However, no detailed information is provided in the program element regarding the operating experience.	Add more detailed information on operating experience based on the reference by H. Asher.	Update the AMP program element.
10.3: (Ginna plant audit) The Ginna SER (NUREG-1786) states the following: The Ginna Station retensioned 23 of the 160 vertical tendons 1000 hours after initial prestressing. Subsequent tests identified that tendon lift-off forces were generally lower than the predicted values. An investigation was started to determine the reason for the accelerated loss of lift-off forces. Prior to completing the investigation, the Ginna Station retensioned the 137 tendons that were not originally retensioned. The investigation concluded that stress relaxation of the tendon wires was the only significant cause for the lower-than-predicted tendon forces. To quantify these findings, a tendon stress relaxation test program was conducted at the Fritz Engineering Laboratory of Lehigh University. The TLAA for the evaluation of loss of prestress in containment tendons concluded that the initial retensioned set of 23 tendons should be	Consider adding “retension of the tendons which experienced loss of prestress prior to the end current license period” as a requirement of preventive action in the GALL SLR TLAA to ensure that prestressing forces remaining above the MRV during the PEO.	Update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
retensioned prior to the end of the current licensing period to ensure that prestressing forces remain above the MRV during the period of extended operation.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 54.21, *Contents of Application-Technical Information*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for In-Service Inspection of Nuclear Power Plant Components, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Plants*, 1992 Edition with 1992 Addenda, The ASME Boiler and Pressure Vessel Code, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for In-Service Inspection of Nuclear Power Plant Components, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Plants*, 1995 Edition with 1996 Addenda, The ASME Boiler and Pressure Vessel Code, The American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for In-Service Inspection of Nuclear Power Plant Components, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Plants*, 2004 edition, The ASME Boiler and Pressure Vessel Code, The American Society of Mechanical Engineers, New York, NY.

H. Ashar, C.P. Tan, D. Naus, *Prestressing in Nuclear Power Plants*, Concrete International, Detroit, Michigan: ACI, May/June 1994.

NRC Information Notice 99-10, *Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments,* U. S. Nuclear Regulatory Commission, April 1999.

NRC Regulatory Guide 1.35.1, *Determining Prestressing Forces for Inspection of Prestressed Concrete Containments,* U. S. Nuclear Regulatory Commission, July 1990.

NUREG/CR-4652, *Concrete Component Aging and its Significance to Life Extension of Nuclear Power Plants*, Oak Ridge National Laboratory, September 1986.

A.49 Drywell Supplement Inspection Program (Plant-Specific)

This is a plant-specific program proposed by NMP-1 plant. It is not included in the GALL Report. The program description and description of the 10 program elements of the program implemented by NMP-1 plant, is included in the following worksheet in blue text. The information source for line items based on visit to NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
(NMP1 DSI program, LR-PBD-DRYWELL., R0) states that the DSI Program manages the aging effects of the areas having major rust on the drywell shell near the underneath the drywell coolers on the 225' elevation structures (six localized areas). The systems or structures managed by this program are: carbon or low alloy drywell, drywell shell in the environments of air or demineralized untreated water (due to maintenance activity).		
a.1: No further review item was identified.		
Program Basis Documents and/or Supporting Documents		
(NMP1 DSI program, LR-PBD-DRYWELL., R0).		
b.1: No further review item was identified.		
Program Consistency and Commitments		
NMPNS will perform volumetric examinations on the NMP1 drywell shell during the 2007 refueling outage and an engineering evaluation will be performed to determine the actions necessary for NMP1 operation through the period of extended operation, in accordance with the NMP1 Drywell Supplemental Inspection Program. (commitment #42)		
c.1: Not applicable, it is a plant-specific program.		
1. Scope of Program		
The scope of the DSI program includes the areas characterized as having major corrosion (rust) on the drywell shell in the NMP-1 Owner activity report dated July 23, 2003. These six areas are localized and located near and underneath the drywell coolers on the 225' elevation. This program invokes aging management activities required by the ASME Section XI Inservice Inspection (Subsection IWE) Program.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1.1: No further review item was identified.		
2. Preventive Actions		
The program is a monitoring program and has no preventive actions in this program.		
2.1: (NMP-1 plant audit) The disposition of NMP-1 CR NM-2006-1276 indicates that there is a need to include preventive actions in the AMP to stop or mitigate corrosion in the drywall. *NMP-1 CR NM-2006-1276* Event: As a result of the LR Challenge Board, it was determined that there were no preventive actions contain in CR-2003-1080 (see above) of the drywell at 225' elevation. Disposition: Revise N1-NMP-201-550 to provide preventive actions.	The AMP should include preventive actions, such as painting the drywall surfaces and cleaning the area coolers during maintenance procedures.	
2.2: (NMP-1 plant audit) For Mark I steel containment, NMP-1 cleans the area coolers during maintenance procedures; this could provide corrosion prevention for the dry well shell near and underneath the coolers and sand pocket region. The GALL program element could contain cleaning of the area coolers in maintenance procedures as a preventive action.	Include cleaning of the area coolers in maintenance procedures as a preventive action to prevent corrosion for the dry well shell near and underneath the coolers and sand pocket region.	Revise or update the AMP program element.
3. Parameters Monitored/Inspected		
Shell thickness is monitored by taking Ultrasonic readings. The six localized areas of the carbon steel drywell shell are examined for evidence of loss of material due to corrosion.		
No further review item was identified.		
4. Detection of Aging Effects		
Loss of material will be detected by performing a volumetric (ultrasonic thickness measurement) examination during 2007 refueling outage. The intended function of the drywell is pressure boundary. Adequacy of the pressure boundary is defined by wall thickness. Monitoring of the wall thickness will ensure that pressure boundary function is maintained.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
The drywell wall thickness will be conducted during the 2007 refueling outage in accordance with ASME IWE requirements. The Ultrasonic examination will be conducted by NDE techniques. Frequency of future inspection will be based on the results obtained. There are six (6) localized areas located near and underneath the drywell area coolers at the 225' elevation subject to material loss due to corrosion (rust). The sample selection to be conducted during the 2007 outage consists of the three worst cases. Expansion of the three additional areas will be based on the initial selection.		
4.1: No further review item was identified.		
5. Monitoring and Trending		
Shell thickness is monitored by taking Ultrasonic readings. The six localized areas of the carbon steel drywell shell are examined for evidence of loss of material due to corrosion.		
5.1: No further review item was identified.		
6. Acceptance Criteria		
The acceptance criteria are based on the calculated corrosion rate (mil/years), margin to design thickness (mils) and the projected wall thickness at the end of extended operation. Depending on corrosion rate, interval of UT measurement ranges from 2 years to 10 years.		
Corrosion rate (mils/year)	Margin to design thickness (mils)	Years reach to minimum design thickness	Actions beyond IWE requirements
< 0.3	> 49	> 190	None
0.30 - 0.60	41-49	93-190	confirming UT every 10 years
0.60 -1.25	25-41	45-93	confirming UT every 6 years
1.25 - 2.2 and	0-25	26-45	conforming UT every 4 years implement a mitigative strategy
> 2.2 and	0	< 26	conforming UT every 2 years implement a mitigative strategy
6.1: No further review item was identified.		
7. Corrective Actions		
NIP-ECP-01 Corrective Actions Program is the administrative procedure that implements the requirements of the corrective action process for 10 CFR 50 Appendix B.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7.1: No further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No further review item was identified.		
9. Administrative Controls		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No further review item was identified.		
10. Operating Experience		
NMPNS has an existing effective program that continuously reviews internal and external operating experience to determine its applicability and adjust inspection plans accordingly. The operating experience program will continue to be used to improve the NMP1 Drywell Supplemental Inspection Program. Program Effectiveness Review: 1. CR NM-2003-1080 Event: Drywell liner has areas of major rust at 225' elevation under area coolers. Disposition: Measurements by UT are greater than the design thickness and determined to be acceptable 2. CR NM-2005-1589 Event: Capture NRC clarification regarding actual minimum thickness for the drywall Disposition: Revise original CBI calculation to eliminate 4.2% overstress from the calculation. Document new design thickness and available margin. 3. CR NM-2006-1276 Event: As a result of LR challenge Board, it was determined that there were no preventive actions contain in CR-2003-1080 (see above) of the drywell at 225' elevation. Disposition: Revise N1-NMP-201-550 to provide preventive actions.		
10.1: No further review item was identified.		

A.50 Torus Corrosion Monitoring Program (Plant-Specific)

This is a plant-specific program proposed by NMP-1 plant. It is not included in the GALL Report. The program description and description of the 10 program elements of the program implemented by NMP-1 plant, is included in the following worksheet in blue text. The information source for line items based on visit to NMP-1 plant is identified in the table; all remaining line items are the result of a general review of the AMP by ANL staff.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The Torus Corrosion Monitoring Program is an existing plant-specific AMP. The purpose of this program is to obtain and analyze NMP-1 Torus wall thickness data for use in establishing the torus shell material ongoing corrosion rate and shell wall thickness. The program includes torus UT measurements and torus coupon analysis. The program also provides visual inspection for the external support structure of the torus.		
a.1: No further review item was identified.		
Program Basis Documents and/or Supporting Documents		
GALL Report XI. S1 ASME Section XI, Subsection IWE		
b.1: No further review item was identified.		
Program Consistency and Commitments		
There is no commitment in Appendix A of the SER for this program.		
c.1: Not applicable, it is a plant-specific program.		
1. Scope of Program		
The program includes torus UT measurements, torus coupon analysis, and torus external support structure visual inspection. Torus UT measurements: The six thinnest (average thickness) locations on the torus shell identified before shall be measured approximately every year. Grid area 18 inside will also be measured every year. Grid 18 is not one the thinnest in terms of average thickness, but has one point, which is close to minimum wall thickness. Torus coupon analysis: The program provides for torus coupons weight and thickness analysis to calculate corrosion loss in estimating corrosion rate of the torus shell. The corrosion rate and data from UT measurements are evaluated for further actions.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Torus external support structure visual inspection: Visual inspection is performed for corrosion and any visible deficiency of the torus support columns, the saddles, and earthquake tie rods. Any corrosion and deficiency will be evaluated.		
1.1: (NMP-1 plant visit) The UT measurements are performed on the preselected areas with known thinnest average wall thickness. This may overlook unexpected corrosion in some other areas.	UT thickness measurements should also be performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell such as pitting corrosion.	Revise or update the AMP program element.
2. Preventive Actions		
The program is a condition monitoring program and has no preventive actions.		
2.1: (NMP-1 plan audit) On the basis of the NMP-1 audit report, the torus shell of NMP-1 is not coated and little margin is left on the wall thickness.	Add a coating to the inside of the torus shell as a preventive measure.	Revise the AMP program element.
3. Parameters Monitored/Inspected		
The torus wall thickness is monitored by UT measurements. The corrosion rate is determined form the coupon analysis. Visual inspections of the torus support structures are performed and the results are compared to previous inspections to determine if there is any loss of material.		
No further review item was identified.		
4. Detection of Aging Effects		
The program is a proactive condition monitoring program that inspections and trends degradation of components to ensure that the torus wall thickness is consistent with the minimum wall requirements and the torus support structure is not degrading. Aging effects will be detected through documented inspections and trending evaluation of data to ensure that degradation is detected prior to loss of intended function. UT measurements are taken at seven locations of torus wall by qualified NDE technicians. 65 readings are taken at a 13x5 grid drawn at each of the seven locations. The UT measurements are taken every year. Torus material coupon analysis is performed in accordance with ASTM G1, 1990. The coupon removal frequency is every six years. Visual inspections of the torus support are performed at each refueling outage.		
4.1: (NMP-1 plant visit) The UT measurements are performed on the preselected areas with known thinnest average wall thickness. This may overlook unexpected corrosion in some other areas.	UT thickness measurements should also be performed at randomly selected areas to ensure there is no unexpected degradation of the torus shell such as pitting corrosion. See comment 1.1 above.	Revise or update the AMP program element.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
5. Monitoring and Trending		
The results of the periodic Torus wall UT measurements and coupon thickness and weight measurements are trended. The data is used to determine whether the wall thickness will reach to its minimum.		
No further review item was identified.		
6. Acceptance Criteria		
Torus Shell: A Condition Report is written if any individual measured wall thickness is less than the 0.431 inch established minimum shell thickness based on the measured corrosion rate, the minimum wall thickness will be reached within four (4) refueling cycles.		
No further review item was identified.		
7. Corrective Actions		
NIP-ECP-01 Corrective Actions Program is the administrative procedure that implements the requirements of the corrective action process for 10 CFR 50 Appendix B.		
7.1: No further review item was identified.		
8. Confirmation Process		
The confirmation process is implemented through Corrective Action Effectiveness Review (NIP-ECA-01).		
8.1: No further review item was identified.		
9. Administrative Controls		
10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
No further review item was identified.		
10. Operating Experience		
Torus wall thinning was observed in the late 1980s following an extended plant shutdown. The wall thinning was attributed to the lay-up conditions inside the torus during the extended shutdown. As a result of this plant specific operating experience, the Torus Corrosion Monitoring Program was established and subsequently approved by NRC SER dated August 11, 1994. There has been no significant degradation found in the torus supports.		
10.1: No further review item was identified.		

A.51 X.E1 Environmental Qualification of Electrical Equipment

The program description and description of the 10 program elements of GALL, Rev. 2, AMP X.E1, Environmental Qualification (EQ) of Electrical Components, are included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The Nuclear Regulatory Commission (NRC) has established nuclear station environmental qualification (EQ) requirements in 10 CFR Part 50, Appendix A, Criterion 4, and 10 CFR 50.49. 10 CFR 50.49 specifically requires that an EQ program be established to demonstrate that certain electrical components located in harsh plant environments (that is, those areas of the plant that could be subject to the harsh environmental effects of a loss of coolant accident (LOCA), high energy line breaks, or post-LOCA environment) are qualified to perform their safety function in those harsh environments after the effects of inservice aging. 10 CFR 50.49 requires that the effects of significant aging mechanisms be addressed as part of environmental qualification. All operating plants shall meet the requirements of 10 CFR 50.49 for certain electrical components important to safety. 10 CFR 50.49 defines the scope of components to be included, requires the preparation and maintenance of a list of in-scope components, and requires the preparation and maintenance of a qualification file that includes component performance specifications, electrical characteristics, and the environmental conditions to which the components could be subjected. 10 CFR 50.49(e)(5) contains provisions for aging that require, in part, consideration of all significant types of aging degradation that can affect component functional capability. 10 CFR 50.49(e)(5) also requires replacement or refurbishment of components not qualified for the current license term prior to the end of designated life, unless additional life is established through ongoing qualification. 10 CFR 50.49(f) establishes four methods of demonstrating qualification for aging and accident conditions. 10 CFR 50.49(k) and (i) permit different qualification criteria to apply based on plant and component vintage. Supplemental EQ regulatory guidance for compliance with these different qualification criteria is provided in the Division of Operating Reactors (DOR) Guidelines; Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Operating Reactors; NUREG-0588, “Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment”; and Regulatory Guide 1.89, Rev. 1, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants.” Compliance with 10 CFR 50.49 provides reasonable assurance that the component can perform its intended functions during accident conditions after experiencing the effects of inservice aging. EQ programs manage component thermal, radiation, and cyclical aging through the use of aging evaluations based on 10 CFR 50.49(f) qualification methods. As required by 10 CFR 50.49, EQ components not qualified for the current license term is refurbished, replaced, or have their qualification extended prior to reaching the aging limits established in the evaluation. Aging evaluations for EQ components that specify a qualification of at least 40 years are considered time-limited aging analyses (TLAAs) for license renewal. Under 10 CFR 54.21(c)(1)(iii), plant EQ programs, which implement the requirements of 10 CFR 50.49 (as further defined and clarified by the DOR Guidelines, NUREG-0588, and Regulatory Guide 1.89, Rev. 1), are viewed as aging management programs (AMPs) for license renewal. Reanalysis of an aging evaluation to extend the qualification of components under 10 CFR 50.49(e) is performed on a routine basis as part of an EQ program. Important attributes for the reanalysis of an aging evaluation include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions (if acceptance criteria are not met). These attributes are discussed in the "EQ Component Reanalysis Attributes" section. This reanalysis program can be applied to EQ components now qualified for the current operating term (i.e., those components now qualified for 40 years or more). As evaluated below, this is an acceptable AMP. Thus, no further evaluation is recommended for license renewal if an applicant elects this option under 10 CFR 54.21(c)(1)(iii) to evaluate the TLAA of EQ of electric equipment. The reanalysis showing the 60-year qualification is established prior to the plant entering the period of extended operation. As defined in 10 CFR 50.49(j), a record of the qualification must be maintained in an auditable form for the entire period of extended operation during which the covered item is installed in the nuclear power plant or is stored for future use; this permits verification that each item of electric equipment important to safety covered by this section (a) is qualified for its application and (b) meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform a safety function up to the end of qualified life.		
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		
b.1: No significant concern or further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Consistency and Commitments		
Ginna Implementation History: **Environmental Qualification of Electrical Equipment – TLAA and AMP B3.1** --Ginna staff contact: David Lovgren Basis document LR-EQ-PRIOGPLAN identified the Ginna extended uprate project. Environmental conditions were recalculated for normal and accident environmental conditions. The engineering report evaluating environmental qualification for the extended uprate project was provided during the audit. EQ equipment including equipment identified as a TLAA for license renewal were evaluated based on the extended power uprate environmental conditions. Procedure EP-3-P-0139 establishes and implements the license renewal commitment while LRTA-01 provides a summary report for the evaluation of EQ electrical equipment for extended operation.		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
EQ programs apply to certain electrical components that are important to safety and could be exposed to harsh environment accident conditions, as defined in 10 CFR 50.49 and Regulatory Guide 1.89, Rev.1.		
1.1: No significant concern or further review item was identified.		
2. Preventive Actions		
10 CFR 50.49 does not require actions that prevent aging effects. EQ program actions that could be viewed as preventive actions include (a) establishing the component service condition tolerance and aging limits (for example, qualified life or condition limit) and (b) where applicable, requiring specific installation, inspection, monitoring, or periodic maintenance actions to maintain component aging effects within the bounds of the qualification basis.		
2.1: No significant concern or further review item was		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
identified.		
3. Parameters Monitored/Inspected		
EQ component qualified life is not based on condition or performance monitoring. However, pursuant to Regulatory Guide 1.89, Rev. 1, such monitoring programs are an acceptable basis to modify a qualified life through reanalysis. Monitoring or inspection of certain environmental conditions or component parameters may be used to ensure that the component is within the bounds of its qualification basis, or as a means to modify the qualified life.		
3.1: No significant concern or further review item was identified.		
4. Detection of Aging Effects		
10 CFR 50.49 does not require the detection of aging effects for in-service components. Monitoring or inspection of certain environmental conditions or component parameters may be used to ensure that the component is within the bounds of its qualification basis, or as a means to modify the qualified life.		
4.1: No significant concern or further review item was identified.		
5. Monitoring and Trending		
10 CFR 50.49 does not require monitoring and trending of component condition or performance parameters of in-service components to manage the effects of aging. EQ program actions that could be viewed as monitoring include monitoring how long qualified components have been installed. Monitoring or inspection of certain environmental, condition, or component parameters may be used to ensure that a component is within the bounds of its qualification basis, or as a means to modify the qualification.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
10 CFR 50.49 acceptance criteria are that an inservice EQ component is maintained within the bounds of its qualification basis, including (a) its established qualified life and (b) continued qualification for the projected accident conditions. 10 CFR 50.49 requires refurbishment, replacement, or requalification prior to exceeding the qualified life of each installed device. When monitoring is used to modify a component qualified life, plant-specific acceptance criteria are established based on applicable 10 CFR 50.49(f) qualification methods.		
6.1: No significant concern or further review item was identified.		
7. Corrective Actions		
If an EQ component is found to be outside the bounds of its qualification basis, corrective actions are implemented in accordance with the station's corrective action program. When unexpected adverse conditions are identified during operational or maintenance activities that affect the environment of a qualified component, the affected EQ component is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions. When an emerging industry aging issue is identified that affects the qualification of an EQ component, the affected component is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions. Confirmatory actions, as needed, are implemented as part of the station's corrective action program, pursuant to 10 CFR 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
Confirmatory actions, as needed, are implemented as part of the station's corrective action program, pursuant to 10 CFR 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No significant concern or further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
9. Administrative Controls		
EQ programs are implemented through the use of station policy, directives, and procedures. EQ programs continue to comply with 10 CFR 50.49 throughout the renewal period, including development and maintenance of qualification documentation demonstrating reasonable assurance that a component can perform required functions during harsh accident conditions. EQ program documents identify the applicable environmental conditions for the component locations. EQ program qualification files are maintained at the plant site in an auditable form for the duration of the installed life of the component. EQ program documentation is controlled under the station's quality assurance program. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
EQ programs include consideration of operating experience to modify qualification bases and conclusions, including qualified life. Compliance with 10 CFR 50.49 provides reasonable assurance that components can perform their intended functions during accident conditions after experiencing the effects of inservice aging.		
Ginna Implementation/Inspections 10.1 The trend reports for the EQ program associated with license renewal indicated no conditions noted. The program health report for the third quarter of 2009 indicated an overall status as “green.” The report did note a large backlog of file revisions due to license renewal and extended power uprate projects. The lack of a qualified backup program owner was also noted. 10.2 The program health report for the third quarter of 2011 indicated an overall status of “white.” The report explains the transition from green to white is due to no qualified backup program owner and the backlog of file revisions	**LESSONS LEARNED FROM AUDIT FOR RECOMMENDATIONS FOR NINE MILES POINT AMP AUDIT** None noted – The backlog of file revisions is a common indicator for plants audited for license renewal.	

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
continued to be a concern. The report identified corrective actions needed for status improvement. 10.3 The EQ program identified transmitter and cable components requiring placement and proposed action and schedules and considered recent industry operating experience. The applicant's Gap Analysis indicated no required program changes for subsequent license renewal. **10.4:** No significant concern or further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.49, *Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 54.21, *Contents of Application—Technical Information*, Office of the Federal Register, National Archives and Records Administration, 2009.

DOR Guidelines, *Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors,* November 1979.

NRC Regulatory Guide 1.89, Rev. 1, *Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,* U. S. Nuclear Regulatory Commission, June 1984.

NRC Regulatory Issue Summary 2003-09, *Environmental Qualification of Low-Voltage Instrumentation and Control Cables*, May 2, 2003.

NUREG-0588, *Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment,* U. S. Nuclear Regulatory Commission, July 1981.

A.52 XI.E1 Cables and Connections

The program description and description of the 10 program elements of GALL, Rev. 2, AMP XI.E1, Cables and Connections, are included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of the aging management program (AMP) described herein is to provide reasonable assurance that the intended functions of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse localized environments caused by temperature, radiation, or moisture are maintained consistent with the current licensing basis through the period of extended operation. In most areas within a nuclear power plant, the actual ambient environments (e.g., temperature, radiation, or moisture) are less severe than the plant design environment. However, in a limited number of localized areas, the actual environments may be more severe than the plant design environment. Insulation materials used in electrical cables and connections may degrade more rapidly than expected in these adverse localized environments. An adverse localized environment is a condition in a limited plant area that is significantly more severe than the plant design environment for the cable or connection insulation material that could increase the rate of aging of a component or have an adverse effect on operability. An adverse localized environment exists based on the most limiting condition for temperature, radiation, or moisture for the insulation material of cables or connections. Adverse localized environments can be identified through the use of an integrated approach. This approach may include, but is not limited to, (a) the review of Environmental Qualification (EQ) zone maps that show radiation levels and temperatures for various plant areas, (b) consultations with plant staff who are cognizant of plant conditions, (c) utilization of infrared thermography to identify hot spots on a real-time basis, and (d) the review of relevant plant-specific and industry operating experience. The program described herein was written specifically to address cables and connections at plants whose configuration is such that most (if not all) cables and connections installed in adverse localized environments are accessible. Cables and connections from accessible areas are inspected and represent, with reasonable assurance, all cables and connections in the adverse localized environments. If an unacceptable condition or situation is identified for a cable or connection in the inspection, a determination is made as to whether the same condition or situation is applicable to inaccessible cables or connections. As such, this program does not apply to plants in which		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
most cables are inaccessible. As stated in NUREG/CR-5643, "the major concern is that failures of deteriorated cable systems (cables, connections, and penetrations) might be induced during accident conditions." Since the cables and connections are not subject to the environmental qualification requirements of 10 CFR 50.49, an AMP is required to manage the aging effects. This AMP provides reasonable assurance the insulation material for electrical cables and connections will perform its intended function for the period of extended operation.		
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		
Ginna, AMP B2.1.11 – Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements The applicant stated that the purpose of the aging management program is to provide reasonable assurance that the intended function of electrical cables and connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to adverse local environments caused by heat, radiation or moisture will be maintained consistent with the current licensing basis through the period of extended operation. The program selects accessible cables and connections subject to an adverse localized environment. Cables and connections are visually inspected for cable and connection jacket anomalies such as embitterment, discoloration, cracking or surface contamination. The accessible cables are considered to represent all cables and connections in the adverse localized environment. Should an unacceptable condition be identified, an evaluation is performed to determine whether the condition is applicable to other accessible or inaccessible cables and connections located in the adverse localized environment. The program is performed every 10 years with the first inspection performed before the end of the current licensing period. The staff safety evaluation report (SER) Section 3.6.2.3.1.1 references the applicant as stating the Electrical Cables and Connections Not Subject to 10 CFR 50.49, Environmental Qualification Requirements program, is consistent with NUREG 1801 and will adequately manage the potential aging effect of these components. In its evaluation, the staff requested clarification of whether the program would be limited to samples within adverse localized environments, or whether all the cables and connections within designated buildings/areas will be inspected. The SER stated that the program was revised to indicate that it is not limited to adverse localized environments but is structured to identify any such areas that may exist in the plant spaces subject to an AMR. The applicant also clarified that should a plant space not contain any significant stressors, a detailed inspection is not likely to occur, but the plant space is not eliminated from future inspections. Future inspections would be performed to verify that no changes in the space occurred that could have added significant stressors or adverse localized environments to the space. The staff concluded in the SER that actions have been identified and have or will be taken to manage the effects of aging during the period of extended operation, such that the intended functions will be maintained for the period of extended operation, as required by 10 CFR 54.21(d).		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Implementation at Ginna: The program is implemented through procedures EP-3-P-0173 and 0174 and the associated work orders were WO# 20703880, 20703289, and 20702304. The walk downs performed consisted of non-intrusive visual inspection and temperature measurement (Infrared) of accessible cables with photographs taken as required. The walk downs included in-scope and out-of-scope components located in the identified locations. Specifically, the inspection noted out-of-scope cables/conduits subjected to elevated temperatures. The inspections identified four cases where debris was found on cable jackets. The cable jackets were noted to be in good condition. Analysis of the debris by the applicant concluded that material degradation was unlikely. The applicant also generated three CRs that identified damaged cable jackets, and improper cable wrapping (tape). A review of trends in CRs from September 24, 2008 through March 31, 2011 listed the above corrective actions with no indication of increasing trends. However, this program is performed on 10 year intervals and therefore additional data would not be generally available.		
b.1: No significant concern or further review item was identified.		
Program Consistency and Commitments		
History of Changes at Ginna: License renewal aging management program basis document LR-CBL1-PROGPLAN Revision 4 for Non-EQ Insulated Cables and Connections Aging Management Program provides a description of the program and associated the activities for the above program credited for license renewal. The basis document implements the modifications noted by the staff SER, including but not limited to adverse localized environments. Therefore, cables identified by the applicant with high loading or in raceway (cable tray) with higher than optimal fill are included in the scope of the program. Commitment No. 9 of the SER implements the Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements program. Basis Document LR-CBL1-PROGPLAN identifies the implementing procedures, establishes repetitive task frequencies, work orders and inspections performed. Procedures identified were EP-3-P-0173 and 0174 and the associated work orders were WO# 20703880, 20703289, and 20702304. The walk downs to be performed consist of non-intrusive visual inspection and temperature measurement (Infrared) of accessible cables with photographs taken as required. No significant changes were noted with regard to OE, NRC requirements, or power uprate.		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
This AMP applies to accessible electrical cables and connections within the scope of license renewal that are located in adverse localized environments caused by temperature, radiation, or moisture.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
1.1: No significant concern or further review item was identified.		
2. Preventive Actions		
This is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.		
2.1: No significant concern or further review item was identified.		
3. Parameters Monitored/Inspected		
Accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable jacket and connection insulation surface anomalies indicating signs of reduced insulation resistance due to thermal/thermoxidative degradation of organics, radiolysis and photolysis (UV sensitive materials only) of organics; radiation-induced oxidation, and moisture intrusion as indicated by signs of embrittlement, discoloration, cracking, melting, swelling or surface contamination. An adverse localized environment is a plant-specific condition; therefore, the applicant should clearly define how this condition is determined. The applicant should determine and inspect the adverse localized conditions for each of the most limiting temperature, radiation, or moisture conditions for the accessible cables and connections that are within the scope of license renewal.		
3.1: This program depends on visual inspection, and inaccessible in-scope cables are not inspected directly, but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. (G3, N1)	The Gall states for plants or areas that have no accessible cables for visual inspection, that this program would not apply and cables in-scope for license renewal may not be inspected. The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated	The definition of "accessible" may need further clarification.
4. Detection of Aging Effects		
Insulation aging degradation from temperature, radiation, or moisture causes cable jacket and connection insulation surface anomalies. Accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable jacket and connection insulation surface anomalies, such as embrittlement, discoloration, cracking, melting, swelling, or surface contamination. The inspection of cable jacket and connection insulation surfaces is used to infer the adequacy of the cables and connections. Accessible electrical cables and connections installed in adverse localized environments are visually inspected at least once every 10 years. This is an adequate period to preclude failures of the cables and connection insulation since experience has shown that aging degradation is a slow process. A 10-year inspection interval provides two data points during a 20-year period, which can be used to characterize the degradation rate. The first inspection for license renewal is to be completed prior to the period of extended operation.		
4.1: See 3.1 above		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
5. Monitoring and Trending		
Trending actions are not included as part of this AMP, because the ability to trend visual inspection results is limited. However, inspection results that are trendable provide additional information on the rate of cable or connection degradation.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
The accessible cables and connections are to be free from unacceptable visual indications of surface anomalies that suggest that cable jacket or connection insulation degradation exists. An unacceptable indication is defined as a noted condition or situation that, if left unmanaged, could lead to a loss of the intended function.		
6.1: See 3.1 above		
7. Corrective Actions		
All unacceptable visual indications of cable jacket and connection insulation surface anomalies are subject to an engineering evaluation. Such an evaluation is to consider the age and operating environment of the component as well as the severity of the anomaly and whether such an anomaly has previously been correlated to degradation of cables or connections. Corrective actions may include, but are not limited to, testing, shielding, or otherwise changing the environment or relocation or replacement of the affected cables or connections. When an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to inaccessible cables or connections. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
identified.		
10. Operating Experience		
Operating experience has shown that adverse localized environments caused by elevated temperature, radiation, or moisture for electrical cables and connections may exist. For example next to or above (within 3 feet of) steam generators, pressurizers, or hot process pipes, such as feedwater lines. These adverse localized environments have been found to cause degradation of the insulating materials on electrical cables and connections that are visually observable, such as color changes or surface cracking. These visual indications can be used as indicators of degradation. This AMP considers the technical information and guidance provided in NUREG/CR-5643, IEEE Std. 1205-2000, SAND96-0344, and EPRI TR-109619.		
10.1: No significant concern or further review item was identified.		
10.2: Ginna Conclusions: Based on the staff audit, the applicant's Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements program is capable of identifying adverse localized environments and identifying affected in-scope cables during the period of extended operation. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results. The applicant's gap analysis for extending this program beyond 60 years did not identify any major program changes required for operation beyond 60 years	No recommendations for Ginna. However, this program depends on visual inspection and inaccessible in-scope cables are not inspected directly but are considered to be subjected to the same environment and aging effects of the visually inspected accessible cable. Therefore, as GALL states for plants or areas that have no accessible cables for visual inspection, this program would not apply and cables in-scope for license renewal may not be inspected	The acceptability of beyond 60 year operation for inaccessible cables using GALL AMP XI.E1 may need to be evaluated. The definition of "accessible" may need further clarification.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI TR-109619, *Guideline for the Management of Adverse Localized Equipment Environments,* Electric Power Research Institute, Palo Alto, CA, June 1999.

IEEE Std. 1205-2000, *IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations.*

NUREG/CR-5643, *Insights Gained From Aging Research,* U. S. Nuclear Regulatory Commission, March 1992.

SAND96-0344, *Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations,* prepared by Sandia National Laboratories for the U.S. Department of Energy, September 1996.

A.53 XI.E2 Cables Used in Instrumentation Circuits

The program description and description of the 10 program elements of GALL, Rev. 2, AMP XI.E2, Cables Used in Instrumentation Circuits, are included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of this aging management program (AMP) is to provide reasonable assurance that the intended functions of electrical cables and connections (that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are used in instrumentation circuits with sensitive, high-voltage, low-level current signals exposed to adverse localized environments caused by temperature, radiation, or moisture) are maintained consistent with the current licensing basis through the period of extended operation. In most areas within a nuclear power plant, the actual ambient environments (e.g., temperature, radiation, or moisture) are less severe than the plant design environment. However, in a limited number of localized areas, the actual environments may be more severe than the design environment. Insulation materials used in electrical cables or connections may degrade more rapidly in adverse localized environments. An adverse localized environment is a condition in a limited plant area that is significantly more severe than the plant design environment for the cable or connection insulation material that could increase the rate of aging of a component or have an adverse effect on operability. Exposure of electrical cable and connection insulation material to adverse localized environments caused by temperature, radiation, or moisture can result in reduced insulation resistance (IR). Reduced IR causes an increase in leakage currents between conductors and from individual conductors to ground. A reduction in IR is a concern for all circuits, but especially those with sensitive, high voltage, low-level current signals, such as radiation monitoring and nuclear instrumentation circuits, because a reduced IR may contribute to signal inaccuracies. In this AMP, either of two methods can be used to identify the existence of aging degradation. In the first method, calibration results or findings of surveillance testing programs are evaluated to identify the existence of cable and connection insulation material aging degradation. In the second method, direct testing of the cable system is performed. This AMP applies to high-range-radiation and neutron flux monitoring instrumentation cables in addition to other cables used in high voltage, low-level current signal applications that are sensitive to reduction in IR. For these cables, AMP XI.E1 does not apply.		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
As stated in NUREG/CR-5643, "the major concern is that failures of deteriorated cable systems (cables, connections, and penetrations) might be induced during accident conditions." Since the instrumentation cables and connections are not subject to the environmental qualification requirements of 10 CFR 50.49, an AMP is required to manage the aging effects. This AMP provides reasonable assurance the insulation material for electrical cables and connections will perform its intended function for the period of extended operation.		
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		
Ginna--AMP B2.1.12 – Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits --Ginna staff contact: David Lovgren AMP B2.1.12 as stated in the applicant's program basis document inspects and tests in-scope cables to provide an indication of the condition of the conductor insulation. In the Ginna LRA, the applicant invoked GALL XI.E1, Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements program instead of GALL XI.E2 to manage the effects of aging of accessible non-EQ cables and connectors. The applicant stating that GALL XI.E1 provides reasonable assurance that these components will perform their intended function during the period of extended operation. Therefore, the applicant included in-scope instrumentation cables associated with low-level signal applications that are sensitive to reduction in insulation resistance (e.g., radiation monitoring and nuclear instrumentation) into LRA AMP B2.1.11, Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements program. In the SER the staff noted that LRA AMP B2.1.11 unlike GALL XI.E2 is a periodic visual inspection program whereas GALL AMP XI.E2, Electrical Cables Not Subject to 10 CFR 50.49 Environmental Qualification requirements Used in Instrumentation Circuits is a calibration program. The staff requested the applicant to provide operational experience to support the applicant's basis for including instrumentation cables associated with low level signal applications in LRA AMP B2.1.11. The applicant response concluded that visual inspection for mechanical aging defects for these circuits is appropriate under LRA AMP B2.1.11 but also stated that the applicant currently performs periodic insulation resistance testing on these circuits. The applicant stated that changes in resistance are sometimes caused by heat or radiation, and that moisture is also a stressor that can cause a reduction in insulation resistance. The applicant stated that they intended to continue the periodic insulation resistance testing through the period of extended operation. The applicant therefore implemented an aging management program to perform insulation resistance testing in addition to the visual inspections performed under AMP B2.1.11. LRA AMP B2.1.12 is performed at least every 10 years with the initial test performed prior to the period of extended operation. The staff accepted the exception for the use of insulation resistance testing and visual inspection as a replacement for GALL XI.E2. This program was identified as Commitment No. 20 in the SER. **History of changes in the Ginna AMP** License renewal aging management program basis document LR-CBL2-PROGPLAN Revision 4 for Electrical Cables Not Subject to 10		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits provides a description of the program and associated activities for the above program credited for license renewal. The basis document through action item AI-2003-011284 implements the exception, modifications and program referenced in the SER including the use of visual inspection and insulation resistance testing as a substitute for GALL XI.E2. Work orders were initiated by action item AI-2003-011284-001 and repetitive tasks were established. Work orders reviewed indicated test performance anomalies but were not inconsistent with expected results. Three corrective actions were noted including a loose connector, disparity between detector readings, and display repair.		
b.1: No significant concern or further review item was identified.		
Program Consistency and Commitments		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
This AMP applies to electrical cables and connections (cable system) used in circuits with sensitive, high voltage, low-level current signals, such as radiation monitoring and nuclear instrumentation, that are subject to aging management review and installed in adverse localized environments caused by temperature, radiation, or moisture.		
1.1: No significant concern or further review item was identified.		
2. Preventive Actions		
This is a performance monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.		
2.1: No significant concern or further review item was identified.		
3. Parameters Monitored/Inspected		
The parameters monitored are determined from the specific calibration, surveillances, or testing performed and are based on the specific instrumentation circuit under surveillance or being calibrated, as documented in plant procedures.		
3.1: No significant concern or further review item was identified.		
4. Detection of Aging Effects		
Review of calibration results or findings of surveillance programs can provide an indication of the existence of aging effects based on		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
acceptance criteria related to instrumentation circuit performance. By reviewing the results obtained during normal calibration or surveillance, an applicant may detect severe aging degradation prior to the loss of the cable and connection intended function. The first reviews are completed prior to the period of extended operation and at least every 10 years thereafter. All calibration or surveillance results that do not meet acceptance criteria are reviewed for aging effects when the results are available. Cable system testing is conducted when the calibration or surveillance program does not include the cabling system in the testing circuit, or as an alternative to the review of calibration results described above. A proven cable system test for detecting deterioration of the insulation system (such as insulation resistance tests, time domain reflectometry tests, or other testing judged to be effective in determining cable system insulation condition as justified in the application) is performed. The test frequency of the cable system is determined by the applicant based on engineering evaluation, but the test frequency is at least once every 10 years. The first test is to be completed prior to the period of extended operation.		
4.1: No significant concern or further review item was identified.		
6. Monitoring and Trending		
Trending actions are not included as part of this AMP because the ability to trend test results is dependent on the specific type of test chosen. However, test results that are trendable provide additional information on the rate of cable or connection degradation.		
5.1: No significant concern or further review item was identified. Ginna Work orders reviewed indicated test performance anomalies but were not inconsistent with expected results. Three corrective actions were noted including a loose connector, disparity between detector readings, and display repair. Work orders were initiated by action item AI-2003-011284-001 and repetitive tasks established.	Ginna Work orders reviewed indicated test performance anomalies but were not inconsistent with expected results. The audit did not identify any adverse trends although program implementation is performed at least once every 10 years, therefore, trending data is limited.	
6. Acceptance Criteria		
Calibration results or findings of surveillance and cable system testing are to be within the acceptance criteria, as set out in the applicant's procedures.		
6.1: No significant concern or further review item was identified.		
7. Corrective Actions		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Corrective actions, such as recalibration and circuit trouble-shooting, are implemented when calibration, surveillance, or cable system test results do not meet the acceptance criteria. An engineering evaluation is performed when the acceptance criteria are not met in order to ensure that the intended functions of the electrical cable system can be maintained consistent with the current licensing basis. Such an evaluation is to consider the significance of the calibration, surveillance, or cable system test results; the operability of the component; the reportability of the event; the extent of the concern; the potential root causes for not meeting the acceptance criteria; the corrective actions required; and likelihood of recurrence. When an unacceptable condition or situation is identified, a determination also is made as to whether the review of calibration and surveillance results or the cable system testing frequency needs to be increased. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address confirmation process**.**		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Operating experience has identified a case where a change in temperature across a high range radiation monitor cable in containment resulted in a substantial change in the reading of the monitor. Changes in instrument calibration can be caused by degradation of the circuit cable and are a possible indication of electrical cable degradation. The vast majority of site-specific and industry wide operating experience regarding neutron flux instrumentation circuits is related to cable/connector issues inside containment near the reactor vessel. This AMP considers the technical information and guidance provided in NUREG/CR-5643, IEEE Std. 1205-2000, SAND96-0344, EPRI TR-109619, NRC IN 97-45, and NRC IN 97-45, Supplement 1.		
10.1: No significant concern or further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
10.2: Ginna Audit Conclusions: Based on the staff audit the applicant's Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements program is capable of identifying adverse localized environments and identifying affected in-scope cables during the period of extended operation. The implementing procedures and associated work orders did not identify unanticipated component degradation or inconclusive results. No significant changes to the AMP were noted. The applicant's AMP LRA AMP B2.1.12 implements GALL XI.E2 through the use of testing and also includes visual inspection. The applicant's gap analysis for extending this program beyond 60 years did not identify any major program changes required for operation beyond 60 years.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI TR-109619, *Guideline for the Management of Adverse Localized Equipment Environments,* Electric Power Research Institute, Palo Alto, CA, June 1999.

IEEE Std. 1205-2000, *IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations.*

NRC Information Notice 97-45, *Environmental Qualification Deficiency for Cables and Containment Penetration Pigtails*, U. S, Nuclear Regulatory Commission, July 2, 1997.

NRC Information Notice 97-45, Supplement 1, *Environmental Qualification Deficiency for Cables and Containment Penetration Pigtails*, U. S, Nuclear Regulatory Commission, February 17, 1998.

NUREG/CR-5643, *Insights Gained From Aging Research,* U. S. Nuclear Regulatory Commission, March 1992. SAND96-0344, *Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations,* prepared by Sandia National Laboratories for the U.S. Department of Energy, September 1996.

A.54 XI.E3 Inaccessible Medium Voltage Cables

The program description and description of the 10 program elements of GALL, Rev. 2, AMP XI.E3, Inaccessible Medium Voltage Cables, are included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
Program Description		
The purpose of the aging management program (AMP) described herein is to provide reasonable assurance that the intended functions of inaccessible or underground power cables that are not subject to the environmental qualification requirements of 10 CFR 50.49 and are exposed to wetting or submergence are maintained consistent with the current licensing basis through the period of extended operation. Most electrical cables in nuclear power plants are located in dry environments. However, some cables may be exposed to wetting or submergence, and are inaccessible or underground, such as cables in conduits, cable trenches, cable troughs, duct banks, underground vaults, or directly buried in soil installations. When a power cable (greater than or equal to 400 volts) is exposed to wet, submerged, or other adverse environmental conditions for which it was not designed, an aging effect of reduced insulation resistance may result, causing a decrease in the dielectric strength of the conductor insulation. This insulation degradation can be caused by wetting or submergence. This can potentially lead to failure of the cable's insulation system. In this AMP, periodic actions are taken to prevent cables from being exposed to significant moisture, defined as periodic exposures to moisture that last more than a few days (e.g., cable wetting or submergence in water. Examples of periodic actions are inspecting for water collection in cable manholes and conduits and draining water, as needed. However, the above actions are not sufficient to ensure that water is not trapped elsewhere in the raceways. For example, (a) if a duct bank conduit has low points in the routing, there could be potential for long-term submergence at these low points; (b) concrete raceways may crack due to soil settling over a long period of time; (c) manhole covers may not be watertight; (d) in certain areas, the water table is high in seasonal cycles, so the raceways may get refilled soon after purging; and (e) potential uncertainties exist with water trees even when duct banks are sloped with the intention to minimize water accumulation. Experience has shown that insulation degradation may occur if the cables are exposed to 100 percent relative humidity. The above periodic actions are necessary to minimize the potential for insulation degradation. In addition to above periodic actions, in-scope power cables exposed to significant moisture are tested to indicate the condition of the conductor insulation. The specific type of test performed is determined prior to the initial test, and is to be a proven test for detecting deterioration of the insulation system due to wetting or		

[6] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
submergence, such as Dielectric Loss (Dissipation Factor/Power Factor), AC Voltage Withstand, Partial Discharge, Step Voltage, Time Domain Reflectometry, Insulation Resistance and Polarization Index, Line Resonance Analysis, or other testing that is state-of-the-art at the time the tests are performed. One or more tests are used to determine the condition of the cables so they will continue to meet their intended function during the period of extended operation. As stated in NUREG/CR-5643, "the major concern is that failures of deteriorated cable systems (cables, connections, and penetrations) might be induced during accident conditions." Because the cables are not subject to the environmental qualification requirements of 10 CFR 50.49, an AMP is required to manage the aging effects. This AMP provides reasonable assurance the insulation material for electrical cables will perform its intended function for the period of extended operation.		
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		
Ginna staff contact: David Lovgren <u>Ginna AMP B2.1.17 – Inaccessible Medium Voltage Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements</u> The applicant identified four medium-voltage power cables installed in underground duct banks but that the failure of these cables would not prevent the satisfactory accomplishment of any intended function. Therefore, the applicant concluded that there were no inaccessible medium voltage cables (2kV to 15kV) within the scope of license renewal. The staff in its SER requested the applicant to identify electrical and I&C components, including medium voltage cables and connections, that were eliminated from aging management activities and the basis for concluding that these components do not provide any license renewal intended functions. The applicant response identified medium voltage cables M0010, M0170, M0089, and M0108 as eliminated from aging management. The staff agreed with the scoping for medium voltage cables M0010 and M0170 but questioned the exclusion of cables M0089 and M0108 from license renewal aging management. In response to the staff's question, the applicant stated that medium voltage cables M0089 and M0108 would be included in the scope of license renewal and provided a new aging management program. The staff reviewed the 10 program elements and found the applicant's Inaccessible Medium Voltage Cables Not Subject to 10 CFR 50.49 Environmental Qualification Requirements to be consistent with GALL XI.E3 Revision 0. The program applies to inaccessible medium voltage cable not subject to the EQ requirements of 10 CFR 50.49 and within the scope of license renewal that are exposed to significant moisture simultaneously with significant voltage. Aging management is performed by testing. This program was identified as Commitment No. 37.		
b.1: No significant concern or further review item was		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
identified.		
Program Consistency and Commitments		
Ginna AMP implementation A review of operating experience included the applicant's responses to GI 2007-01, "Inaccessible or Underground Power cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients," indicate no record of inaccessible or underground cable failures within the scope of 10 CFR 50.65 for Ginna. The applicant also stated in their GL 2007-01 response that repetitive tasks were established and test are performed on inaccessible or underground cable within the scope 10 CFR 50.65. Post approval license renewal inspections did not identify NRC identified or self-revealing findings. The plant integrated inspection report dated January 20, 2011 did not indicate any findings. The report noted that the applicant performed inspection of cables located in manholes using procedure CNG-AM-1.01-1029, Medium Voltage Cable Program. The inspection noted that the offsite power cables had previously been submerged and that the applicant had implemented a preventive maintenance program to pump water accumulated in manholes. The inspection noted that cables were not submerged in water at the time of inspection.		
c.1: No significant concern or further review item was identified.		
11. Scope of Program		
This AMP applies to all inaccessible or underground (e.g., in conduit, duct bank, or direct buried) power cables (greater than or equal to 400 volts) within the scope of license renewal exposed to adverse environments, primarily significant moisture. Significant moisture is defined as periodic exposures to moisture that last more than a few days (e.g., cable wetting or submergence in water). Submarine or other cables designed for continuous wetting or submergence are not included in this AMP.		
Ginna: The applicant performed a barrier analysis for IN 2010-26, "Submerged Electrical Cables," The IN informs applicants of observations of protracted cable submergence in water, recent NRC inspection findings, and the results of licensee's responses to GL 2007-01. Additional clarification is provided for previous information notice IN-2002-12. The barrier analysis evaluated low and medium voltage power cables installed in wet or potentially wet environments for which the cables were not designed. Applicant condition reports identified offsite power circuit cables found submerged. The applicant established repetitive tasks for the offsite power circuit underground duct banks that inspects and pumps out these manholes on a weekly basis. A condition report was also initiated to complete the scoping of medium voltage cables The program with respect to in-scope medium voltage cable as implemented per GALL AMP XI.E3 Revision 1 was consistent with this program. In response to NRC generic communications, industry initiatives and industry operating experience has initiated modifications to the program. Among the changes noted was the inclusion of cables not in-scope of license renewal, the addition of inspections of manhole/vaults for cable subjected to submergence and removal of water as required. The frequency of inspection was adjusted (increased) based on as-found conditions. The applicant initiated a review of additional test methodologies to be considered in the		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
program. In addition, a low-voltage cable program was initiated by the applicant. No unanticipated component or structural degradation was noted among the information reviewed during the audit.		
1.1: The scope of XI.E3 is currently only inaccessible power cables equal to or greater than 400V. Ginna: The applicant identified six cables including in-scope cables (M0108 and M0089) as part of the revised medium voltage program. A new procedure was established for these cables (CNG-AM-1.01-1029). The program includes testing and inspection (offsite power circuits) for water accumulation. The applicant performed a barrier analysis for IN 2010-26, "Submerged Electrical Cables," The IN informs applicants of observations of protracted cable submergence in water, recent NRC inspection findings, and the results of licensee's responses to GL 2007-01. Additional clarification is provided for previous information notice IN-2002-12. The barrier analysis evaluated low and medium voltage power cables installed in wet or potentially wet environments for which the cables were not designed. Applicant condition reports identified offsite power circuit cables found submerged	Ginna: The applicant established repetitive tasks for the offsite power circuit underground duct banks that inspects and pumps out these manholes on a weekly basis. A condition report was also initiated to complete the scoping of medium voltage cables	Consideration should be given to whether future versions of XI.E3 scope should include lower voltages (0 to 1000 V power cable).
12. Preventive Actions		
This is a condition monitoring program. However, periodic actions are taken to prevent inaccessible cables from being exposed to significant moisture, such as identifying and inspecting in-scope accessible cable conduit ends and cable manholes for water collection, and draining the water, as needed. The inspection frequency for water collection is established and performed based on plant-specific operating experience with cable wetting or submergence in manholes (i.e., the inspection is performed periodically based on water accumulation over time and event driven occurrences, such as heavy rain or flooding). The periodic inspection should occur at least annually. The inspection should include direct observation that cables are not wetted or submerged, that cables/splices and cable support structures are intact, and that dewatering/drainage systems (i.e., sump pumps) and associated alarms operate properly. In addition, operation of dewatering devices should be inspected and operation verified prior to any known or predicted heavy rain or flooding events. If water is found during inspection (i.e., cable exposed to significant moisture), corrective actions are taken to keep the cable dry and to assess cable degradation. The first inspection for license renewal is completed prior to the period of extended operation.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
2.1: No significant concern or further review item was identified.		
13. Parameters Monitored/Inspected		
Inspection for water collection is performed based on plant-specific operating experience with water accumulation in the manhole. Inaccessible or underground power (greater than or equal to 400 volts) cables within the scope of license renewal exposed to significant moisture are tested to provide an indication of the condition of the conductor insulation. The specific type of test to be used should be capable of detecting reduced insulation resistance of the cable's insulation system due to wetting or submergence.		
3.1: No significant concern or further review item was identified.		
14. Detection of Aging Effects		
For power cables exposed to significant moisture, test frequencies are adjusted based on test results (including trending of degradation where applicable) and operating experience. Cable testing should occur at least once every 6 years. A 6-year interval provides multiple data points during a 20-year period, which can be used to characterize the degradation rate. This is an adequate period to monitor performance of the cable and take appropriate corrective actions since experience has shown that although a slow process, aging degradation could be significant. The first tests for license renewal are to be completed prior to the period of extended operation with subsequent tests performed at least every 6 years thereafter. The applicant can assess the condition of the cable insulation with reasonable confidence using one or more of the following techniques: Dielectric Loss (Dissipation Factor/Power Factor), AC Voltage Withstand, Partial Discharge, Step Voltage, Time Domain Reflectometry, Insulation Resistance and Polarization Index, Line Resonance Analysis, or other testing that is state-of-the-art at the time the tests are performed. One or more tests are used to determine the condition of the cables so they will continue to meet their intended function during the period of extended operation.		
4.1: No significant concern or further review item was identified.		
15. Monitoring and Trending		
Trending actions are included as part of this AMP, although the ability to trend results is dependent on the specific type of test(s) or inspection chosen. Results that are trendable provide additional information on the rate of cable insulation degradation.		
5.1: No significant concern or further review item was identified.		
16. Acceptance Criteria		
The acceptance criteria for each test are defined by the specific type of test performed and the specific cable tested. Acceptance criteria for inspections of manholes are defined by the observation that the cables and support structures are not submerged or immersed in standing water at the time of the inspection.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
6.1: No significant concern or further review item was identified.		
17. Corrective Actions		
Corrective actions are taken and an engineering evaluation is performed when the test or inspection acceptance criteria are not met. Such an evaluation considers the significance of the test or inspection results, the operability of the component, the reportability of the event, the extent of the concern, the potential root causes for not meeting the test or inspection acceptance criteria, the corrective actions required, and the likelihood of recurrence. When an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to other accessible or inaccessible, in-scope power cables. Corrective actions may include, but are not limited to, installation of permanent drainage systems, installation of sump pumps and alarms, more frequent cable testing or manhole inspections, or replacement of the affected cable. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
18. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No significant concern or further review item was identified.		
19. Administrative Controls		
The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
20. Operating Experience		
Operating experience has shown that insulation materials are susceptible to water tree formation. The formation and growth of water trees varies directly with operating voltage. Aging effects of reduced insulation resistance due to other mechanisms may also result in a decrease in the dielectric strength of the conductor insulation. Minimizing exposure to moisture mitigates the potential for the development of reduced insulation resistance. Recent incidents involving early failures of electric cables and cable failures leading to multiple equipment failures, are cited in NRC IN 2002-12, “Submerged Safety-Related Cables,” and NRC GL 2007-01, “Inaccessible or Underground Power Cable Failures That Disable		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
Accident Mitigation Systems or Cause Plant Transients." The NRC issued GL 2007-001 on inaccessible or underground cables to (a) inform licensees that the failure of certain power cables can affect the functionality of multiple accident mitigation systems or cause plant transients and (b) gather information from licensees on the monitoring of inaccessible or underground power cable failures for all cables that are within the scope of the Maintenance Rule. Based on the review of licensees' responses, the NRC staff has identified 269 cable failures for 104 reactor units. The data obtained from the GL responses show an increasing trend of cable failures. The NRC staff has noted that the predominant factor contributing to cable failures at nuclear power plants was due to moisture/submergence. The staff also noted that the GL failure data show that the majority of the reported failures occurred at the 4160-volt, 480 volt, and 600-volt service voltage levels for both energized and de-energized cables. These cables are failing within the plants' 40-year licensing period. The NRC inspectors also have continued to identify safety-related cables which are submerged. The staff noted that licensees had not demonstrated that the subject safety-related cables were designed for wetted or submerged service for the current license period. This AMP considers the technical information and generic communication guidance provided in NUREG/CR-5643; IEEE Std. 1205-2000; SAND96-0344; EPRI 109619; EPRI 103834-P1-2; NRC IN 2002-12; NRC GL 2007-01; NRC GL 2007-01 Summary Report; NRC Inspection Procedure, Attachment 71111.06, Flood Protection Measures; NRC Inspection Procedure, Attachment 71111.01, Adverse Weather Protection; RG 1.211 Rev 0; DG-1240; and NUREG/CR-7000.		
10.1: No significant concern or further review item was identified. Ginna: A review of trending reports did not indicate any applicable medium-voltage cable condition reports with respect to license renewal. No trend reports have yet to be generated for the new low voltage program as this program is under development. A review of medium voltage cable program health reports for 2010 found most categories acceptable. However, red categories were noted for backup program owner/industry participation, yellow for program infrastructure (equipment and qualification and red for test and monitoring equipment. The summary report described this as a new program. A condition report was generated subsequent to the health report addressing the issues identified for the medium voltage program. The medium voltage cable program is not		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[6]
consistent with GALL XI.E3 Revision 2 with regard to event driven occurrences, the use of the significant voltage criterion, and inspections and test frequencies. Basis Document LR-IMV-PROGPLAN states that a repetitive task test frequency of 6 years was established for in-scope cable testing which is consistent with GALL 2. In addition, the significant voltage criterion did not appear to be applicable to the scoping of in-scope medium voltage cables and work orders identify the performance of manhole inspections although in-scope cables are not specifically identified in the inspection.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

EPRI TR-103834-P1-2, *Effects of Moisture on the Life of Power Plant Cables,* Electric Power Research Institute, Palo Alto, CA, August 1994.

EPRI TR-109619, *Guideline for the Management of Adverse Localized Equipment Environments,* Electric Power Research Institute, Palo Alto, CA, June 1999.

IEEE Std. 1205-2000, *IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations.*

NRC Draft Regulatory Guide DG-1240, *Condition Monitoring Program for Electric Cables Used In Nuclear Power Plants*, June 2010.

NRC Generic Letter 2007-01, Summary Report, *Inaccessible or Underground Power Cable Failures that Disable Accident Mitigation Systems or Cause Plant Transients*, November 12, 2008.

NRC Inspection Procedure, Attachment 71111.06, *Flood Protection Measures*, June 25, 2009.

NRC Inspection Procedure, Attachment 71111.01, *Adverse Weather Protection*, April 8, 2009.

NRC Information Notice 2002-12, *Submerged Safety-Related Electrical Cables*, March 21, 2002.

NRC Regulatory Guide 1.211 Rev 0, *Qualification of Safety-Related Cables and Field Splices for Nuclear Power Plants*, April 2009.

NUREG/CR-5643, *Insights Gained From Aging Research,* U. S. Nuclear Regulatory Commission, March 1992.

NUREG/CR-7000, *Essential Elements of an Electric Cable Condition Monitoring Program*, January 2010.

SAND96-0344, *Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations,* prepared by Sandia National Laboratories for the U.S. Department of Energy, September 1996.

A.55 XI.E4 Non-Segregated Bus

The program description and description of the 10 program elements of GALL, Rev. 2, AMP XI.E4, Non-Segregated Bus, is included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of this aging management program (AMP) is to provide an internal and external inspection of Metal Enclosed Buses (MEBs) to identify age-related degradation of insulating material (i.e., porcelain, xenoy, thermoplastic organic polymers), and metallic and elastomer components (e.g., gaskets, boots, and sealants). MEBs are electrical buses installed on electrically insulated supports that are constructed with each phase conductor enclosed in a separate metal enclosure (isolated phase bus), all conductors enclosed in a common metal enclosure (non-segregated bus), or all phase conductors in a common metal enclosure, but separated by metal barriers between phases (segregated bus). The conductors are adequately separated and insulated from ground by insulating supports or bus insulation. The MEBs are used in power systems to connect various elements in electric power circuits, such as switchgear, transformers, main generators, and diesel generators. Industry operating experience indicates that failures of MEBs have been caused by cracked insulation and moisture, debris, or excessive dust buildup internal to the bus duct housing. Cracked insulation has resulted from high ambient temperature and contamination from bus bar joint compounds. Cracked insulation in the presence of moisture or debris has provided phase-to-phase or phase-to-ground electrical tracking paths, which has resulted in catastrophic failure of the buses. Bus failure has led to loss of power to electrical loads connected to the buses, causing subsequent reactor trips and initiating unnecessary challenges to plant systems and operators. MEBs may experience increased resistance of connection due to loosening of bolted bus duct connections caused by repeated thermal cycling of connected loads. This phenomenon can occur in heavily loaded circuits (i.e., those exposed to appreciable ohmic heating). For example, SAND 96-0344 identified instances of termination loosening at several plants due to thermal cycling and NRC IN 2000-14 identified torque relaxation of splice plate connecting bolts as one potential cause of a MEB fault. This AMP includes the inspection of all bus ducts within the scope of license renewal and a sample of accessible MEB bolted connections for increased resistance of connection. The technical basis for the sample selections should be documented. If an unacceptable condition or situation is identified in the selected sample, a determination is made as to whether the same condition or situation is		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
applicable to other connections not tested.		
a.1: No significant concern or further review item was identified.		
a.2: Ginna – we have no report on file for this AMP (?)		
Program Basis Documents and/or Supporting Documents		
b.1: No significant concern or further review item was identified.		
Program Consistency and Commitments		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
This AMP manages the age-related degradation effects for electrical bus bar bolted connections, bus bar insulation, bus bar insulating supports, bus enclosure assemblies (internal and external), and elastomers. This program does not manage the aging effects on external bus structural supports, which are managed under AMP XI.S6, "Structures Monitoring." Alternatively, the aging effects on elastomers can be managed under AMP XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components," and the external surfaces of MEB enclosure assemblies can be managed under AMP XI.S6, "Structures Monitoring."		
1.1: No significant concern or further review item was identified.		
2. Preventive Actions		
This is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation.		
2.1: No significant concern or further review item was identified.		
3. Parameters Monitored/Inspected		
This AMP provides for the inspection of the internal and external portions of the MEB. Internal portions (bus enclosure assemblies) of the MEB are inspected for cracks, corrosion, foreign debris, excessive dust buildup, and evidence of water intrusion. The bus insulation is inspected for signs of reduced insulation resistance due to thermal/thermoxidative degradation of organics/thermoplastics, radiation-		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
induced oxidation, moisture/debris intrusion, or ohmic heating, as indicated by embrittlement, cracking, chipping, melting, discoloration, or swelling, which may indicate overheating or aging degradation. The internal bus insulating supports are inspected for structural integrity and signs of cracks. A sample of accessible bolted connections is inspected for increased resistance of connection. Alternatively, for accessible bolted connections covered with heat shrink tape, sleeving, insulating boots, etc., the sample may be visually inspected for insulation material surface anomalies. The external portions of the MEB, including accessible gaskets, boots, and sealants, are inspected for hardening and loss of strength due to elastomer degradation that could permit water or foreign debris to enter the bus. MEB external surfaces are inspected for loss of material due to general, pitting, and crevice corrosion.		
3.1: No significant concern or further review item was identified.		
4. Detection of Aging Effects		
MEB internal surfaces are visually inspected for aging degradation including cracks, corrosion, foreign debris, excessive dust buildup, and evidence of moisture intrusion. MEB insulating material is visually inspected for signs of embrittlement, cracking, chipping, melting, discoloration, swelling, or surface contamination. Internal bus insulating supports are visually inspected for structural integrity and signs of cracks. MEB external surfaces are visually inspected for loss of material due to general, pitting, and crevice corrosion. Accessible elastomers (e.g., gaskets, boots, and sealants) are inspected for degradation including surface cracking, crazing, scuffing, dimensional change (e.g. “ballooning” and “necking”), shrinkage, discoloration, hardening and loss of strength. A sample of accessible bolted connections is inspected for increased resistance of connection by using thermography or by measuring connection resistance using a micro-ohmmeter. Twenty percent of the population with a maximum sample of 25 constitutes a representative sample size. Otherwise, a technical justification of the methodology and sample size used for selecting components should be included as part of the AMP’s site documentation. If an unacceptable condition or situation is identified in the selected sample, a determination is made as to whether the same condition or situation is applicable to other connections not tested. The first inspection using thermography or measuring connection resistance is completed prior to the period of extended operation and every 10 years thereafter provided visual inspection is not used to inspect bolted connections. This is an adequate period to preclude failures of the MEBs since experience has shown that MEB aging degradation is a slow process. As an alternative to thermography or measuring connection resistance of bolted connections, for accessible bolted connections that are covered with heat shrink tape, sleeving, insulating boots, etc., the applicant may use visual inspection of insulation material to detect surface anomalies, such as embrittlement, cracking, chipping, melting, discoloration, swelling, or surface contamination. When this alternative visual inspection is used to check the bolted connection sample, the first inspection is completed prior to the period of extended operation and every 5 years thereafter.		
4.1: No significant concern or further review item was identified.		
5. Monitoring and Trending		
Trending actions are not included as part of this AMP because the ability to trend inspection results is limited. However, results that are		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
trendable provide additional information on the rate of degradation.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
MEB insulation materials are free from regional indications of surface anomalies such as embrittlement, cracking, chipping, melting, discoloration, and swelling, or surface contamination. MEB internal surfaces show no indications of corrosion, cracks, foreign debris, excessive dust buildup, or evidence of moisture intrusion. Accessible elastomers (e.g., gaskets, boots, and sealants) show no indications of surface cracking, crazing, scuffing, dimensional change (e.g. “ballooning” and “necking”), shrinkage, discoloration, hardening, and loss of strength. MEB external surfaces are free from loss of material due to general, pitting, and crevice corrosion. Bolted connections need to be below the maximum allowed temperature for the application when thermography is used or a low resistance value appropriate for the application when resistance measurement is used. When the visual inspection alternative for bolted connections is used, the absence of embrittlement, cracking, chipping, melting, discoloration, swelling, or surface contamination of the insulation material provides positive indication that the bolted connections are not loose.		
6.1: No significant concern or further review item was identified.		
7. Corrective Actions		
Corrective actions are taken and an engineering evaluation is performed when the acceptance criteria are not met. Corrective actions may include, but are not limited, to cleaning, drying, increased inspection frequency, replacement, or repair of the affected MEB components. If an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to other accessible or inaccessible MEBs. As discussed in Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Industry experience has shown that failures have occurred on MEBs caused by cracked insulation and moisture or debris buildup internal to the MEB. Experience also has shown that bus connections in the MEBs exposed to appreciable ohmic heating during operation may experience loosening due to repeated cycling of connected loads. This AMP considers the technical information and guidance provided in SAND 96-0344, IEEE Std. 1205-2000, NRC IN 89-64, NRC IN 98-36, NRC IN 2000-14, and NRC IN 2007-01.		
10.1: No significant concern or further review item was identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

IEEE Std. 1205-2000, *IEEE Guide for Assessing, Monitoring and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations*.

NRC Information Notice 89-64, *Electrical Bus Bar Failures*, September 7, 1989.

NRC Information Notice 98-36, *Inadequate or Poorly Controlled, Non-Safety-Related Maintenance Activities Unnecessary Challenged Safety Systems*, September 18, 1998.

NRC Information Notice 2000-14, *Non-Vital Bus Fault Leads to Fire and Loss of Offsite Power*, September 27, 2000.

NRC Information Notice 2007-01, *Recent Operating Experience Concerning Hydrostatic Barriers*, January 31, 2007. SAND 96-0344, *Aging Management Guideline for Commercial Nuclear Power Plants – Electrical Cable and Terminations*, prepared by Sandia National Laboratories for the U.S. Department of Energy, September 1996.

A.56 XI.E5 Fuse Program

The program description and description of the 10 program elements of GALL, Rev. 2, AMP XI.E5, Fuse Program, is included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of the aging management program (AMP) described herein is to provide reasonable assurance that the intended functions of the metallic clamps of fuse holders are maintained consistent with the current licensing basis through the period of extended operation. Fuse holders (fuse blocks) are classified as a specialized type of terminal block because of the similarity in fuse holder design and construction to that of a terminal block. Fuse holders are typically constructed of blocks of rigid insulating material, such as phenolic resins. Metallic clamps (clips) are attached to the blocks to hold each end of the fuse. The clamps, which are typically made of copper, can be spring-loaded clips that allow the fuse ferrules or blades to slip in, or they can be bolt lugs, to which the fuse ends are bolted. AMP XI.E1, “Insulation for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements,” manages the aging of insulating material but not the metallic clamps of the fuse holders. The AMP for fuse holders (metallic clamps) needs to account for the following aging stressors if applicable: increased resistance of connection due to chemical contamination, corrosion, and oxidation or fatigue caused by ohmic heating, thermal cycling, electrical transients, frequent manipulation, or vibration. AMP XI.E1 is based on only a visual inspection of accessible cables and connections. Visual inspection is not sufficient to detect the aging effects from chemical contamination, corrosion, oxidation, fatigue, or vibration on the metallic clamps of the fuse holder. Fuse holders that are within the scope of license renewal should be tested to provide an indication of the condition of the metallic clamps of the fuse holders. The specific type of test performed is determined prior to the initial test and is to be a proven test for detecting deterioration of metallic clamps of the fuse holders, such as thermography, contact resistance testing, or other appropriate testing justified in the application. As stated in NUREG-1760, “Aging Assessment of Safety-Related Fuses Used in Low and Medium-Voltage Applications in Nuclear Power Plants,” fuse holders experience a number of age-related failures. The major concern is that failures of a deteriorated cable system (cables, connections including fuse holders, and penetrations) might be induced during accident conditions. Since they are not subject to the environmental qualification requirements of 10 CFR 50.49, an AMP is required to manage the aging effects. This AMP ensures that		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
fuse holders will perform their intended function for the period of extended operation.		
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		
Ginna **Fuse Program,** staff contact: David Lovgren The GALL 2 Fuse program XI.E5 (metallic portion of the fuse holder) and associated aging mechanisms were not addressed in GALL Revision 0 and therefore not addressed by the applicant in its LRA. The staff in its SER identified the metallic portion of fuse holders as a component not addressed in XI.E1 which manages the insulated portion of cables and connectors. The staff referenced its ISG on fuse holders and asked the applicant to address the metallic portion of fuse holders for license renewal at Ginna. The staff indicated that they were working with industry to develop an appropriate GALL AMP. The staff requested the applicant address the ISG. In the applicant's response, the applicant stated that they had reviewed plant specific history including corrective actions and industry operating experience, performed select visual inspections, and concluded that the fuses that meet the intended scope of the ISG do not have aging effects requiring aging management within the period of extended operation (fuse not part of a larger assembly). The staff in its SER accepted the applicant's evaluation The applicant's Gap Analysis identified this as a new program with a 10 year inspection cycle.		
b.1: No significant concern or further review item was identified.		
Program Consistency and Commitments		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
This AMP manages fuse holders (metallic clamps) located outside of active devices that are considered susceptible to the following aging effects: increased resistance of connection due to chemical contamination, corrosion, and oxidation or fatigue caused by ohmic heating, thermal cycling, electrical transients, frequent manipulation, or vibration. Fuse holders inside an active device (e.g., switchgear, power supplies, power inverters, battery chargers, and circuit boards) are not within the scope of this AMP.		
1.1: No significant concern or further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
2. Preventive Actions		
This is a condition monitoring program and no actions are taken as part of this program to prevent or mitigate aging degradation. =		
2.1: No significant concern or further review item was identified.		
3. Parameters Monitored/Inspected		
The metallic clamp portion of the fuse holder is tested to provide an indication of increased resistance of the connection due to chemical contamination, corrosion, and oxidation or fatigue caused by ohmic heating, thermal cycling, electrical transients, frequent manipulation or vibration.		
3.1: No significant concern or further review item was identified.		
4. Detection of Aging Effects		
Fuse holders within the scope of license renewal are tested at least once every 10 years to provide an indication of the condition of the metallic clamp of the fuse holder. Testing may include thermography, contact resistance testing, or other appropriate testing methods. This is an adequate period to preclude failures of the fuse holders since experience has shown that aging degradation is a slow process. A 10-year testing interval provides two data points during a 20-year period, which can be used to characterize the degradation rate. The first tests for license renewal are to be completed prior to the period of extended operation.		
4.1: No significant concern or further review item was identified.		
5. Monitoring and Trending		
Trending actions are not included as part of this AMP because the ability to trend test results is dependent on the specific type of test chosen. However, results that are trendable provide additional information on the rate of degradation.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
The acceptance criteria for each test are defined by the specific type of test performed and the specific type of fuse holder tested. The metallic clamp of the fuse holder needs to be below the maximum allowed temperature for the application when thermography is used; otherwise, a low resistance value appropriate for the application when resistance measurement is used.		
6.1: No significant concern or further review item was identified.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
7. Corrective Actions		
Corrective actions are taken and an engineering evaluation is performed when the test acceptance criteria are not met in order to ensure that the intended functions of the fuse holders can be maintained consistent with the current licensing basis. Such an evaluation is to consider the significance of the test results, the operability of the component, the reportability of the event, the extent of the concern, the potential root causes for not meeting the test acceptance criteria, the corrective action necessary, and the likelihood of recurrence. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Operating experience has shown that loosening of fuse holders and corrosion of fuse clips are aging mechanisms that, if left unmanaged, can lead to a loss of electrical continuity function. Operating experience in NUREG-1760 documented fuse holder failures due to fatigue and recommends maintenance procedures be reviewed to minimize removal and reinsertion of fuses to de-energize components (as this can lead to degradation of the fuse holders). This AMP considers the technical information and guidance provided in NUREG-1760, IEEE Std. 1205-2000, NRC IN 86-87, NRC IN 87-42, and NRC IN 91-78. Ginna: Staff audit did not look at fuse holder operating experience post license renewal and did not compare the ISG, GALL1 and GALL 2 fuse programs. The aging stressors noted by the applicant are consistent with those identified in GALL Revision 2.		
10.1: No significant concern or further review item was		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
identified.		

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

IEEE standard 1205-2000, *IEEE Guide for Assessing, Monitoring, and Mitigating Aging Effects on Class 1E Equipment Used in Nuclear Power Generating Stations*.

NRC Information Notice 86-87, *Loss of Offsite Power Upon an Automatic Bus Transfer*, October 10, 1986.

NRC Information Notice 87-42, *Diesel Generator Fuse Contacts*, September 4, 1987.

NRC Information Notice 91-78, *Status Indication of Control Power for Circuit Breakers Used in Safety-Related Application*, November 28, 1991.

NUREG-1760*, Aging Assessment of Safety-Related Fuses Used in Low- and Medium-Voltage Applications in Nuclear Power Plants*, May 31, 2002.

A.57 XI.E6 Electrical Connections Program - Metallic

The program description and description of the 10 program elements of GALL, Rev. 2, AMP XI.E6, Electrical Connections Program - Metallic, is included in the following worksheet in blue text. The source of the information in each line item that is based on the visits to Ginna and NMP-1 plants is identified in the table.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Program Description		
The purpose of the aging management program (AMP) described herein is to provide reasonable assurance that the intended functions of the metallic parts of electrical cable connections that are not subject to the environmental qualification requirements of 10 CFR 50.49 and susceptible to age-related degradation resulting in increased resistance of connection due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation are maintained consistent with the current licensing basis through the period of extended operation. Cable connections are used to connect cable conductors to other cable conductors or electrical devices. Connections associated with cables within the scope of license renewal are part of this AMP. The most common types of connections used in nuclear power plants are splices (butt or bolted), crimp-type ring lugs, connectors, and terminal blocks. Most connections involve insulating material and metallic parts. This AMP focuses on the metallic parts of the electrical cable connections. This AMP provides a one-time test, on a sampling basis, to ensure that either aging of metallic cable connections is not occurring and/or that the existing preventive maintenance program is effective such that a periodic inspection program is not required. The one-time test confirms the absence of age-related degradation of cable connections resulting in increased resistance of connection due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation. AMP XI.E1, “Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements,” manages the aging of insulating material but not the metallic parts of the electrical connections. AMP XI.E1 is based on a visual inspection of accessible cables and connections. Visual inspection may not be sufficient to detect the aging effects from thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation on the metallic parts of cable connections. Electrical cable connections exposed to appreciable ohmic or ambient heating during operation may experience increased resistance of connection caused by repeated cycling of connected loads or of the ambient temperature environment. Different materials used in various cable system components can produce situations where stresses between these components change with repeated thermal cycling. For		

[1] Proposed action for revision of the GALL Rev. 2 AMP for subsequent license renewal.

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
example, under loaded conditions, ohmic heating may raise the temperature of a compression terminal and cable conductor well above the ambient temperature, thereby causing thermal expansion of both components. Thermal expansion coefficients of different materials may alter mechanical stresses between the components and may adversely impact the termination. When the current is reduced, the affected components cool and contract. Repeated cycling in this fashion can cause loosening of the termination and may lead to increased resistance of connection or eventual separation of compression-type terminations. Threaded connectors may loosen if subjected to significant thermally-induced stress and cycling. Cable connections within the scope of license renewal should be tested at least once prior to the period of extended operation to provide an indication of the integrity of the cable connections. The specific type of test to be performed is a proven test for detecting increased resistance of connection, such as thermography, contact resistance testing, or another appropriate test. As an alternative to thermography or resistance measurement of cable connections, for the accessible cable connections that are covered with insulation materials such as tape, the applicant may perform visual inspection of insulation material to detect aging effects for covered cable connections. When this alternative visual inspection is used to check cable connections, the applicant must use periodic inspections and cannot use a one-time test to confirm the absence of age-related degradation of cable connections. The basis for performing only a periodic visual inspection is documented. This AMP, as described, is a sampling program. The following factors are considered for sampling: voltage level (medium and low voltage), circuit loading (high loading), connection type and location (high temperature, high humidity, vibration, etc.). The technical basis for the sample selections should be documented. If an unacceptable condition or situation is identified in the selected sample, a determination is made as to whether the same condition or situation is applicable to other connections not tested. The corrective action program is used to evaluate the condition and determine appropriate corrective action. SAND96-0344, “Aging Management Guidelines for Electrical Cable and Terminations,” indicated that loose terminations were identified by several plants. The major concern is failures of a deteriorated cable system (cables, connections including fuse holders, and penetrations) that could prevent it from performing its intended function. This AMP is not applicable to cable connections in harsh environments since they are already addressed by the requirements of 10 CFR 50.49. Even though cable connections may not be exposed to harsh environments, increased resistance of connection is a concern due to the aging mechanisms discussed above.		
a.1: No significant concern or further review item was identified.		
Program Basis Documents and/or Supporting Documents		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Ginna Electrical Connections - metallic parts The GALL 2 Electrical Connections program XI.E6 (metallic portion of the connection) and associated aging mechanisms were not addressed in GALL Revision 0 and therefore not addressed by the applicant in its LRA. The staff in its SER identified only electrical connections subjected to boric acid water leakage components. The metallic portion of connections as a component is not addressed in XI.E1 which manages the insulated portion of cables and connectors. The applicant's Gap Analysis identified this as a new program with a 10 year inspection cycle.		
b.1: No significant concern or further review item was identified.		
Program Consistency and Commitments		
c.1: No significant concern or further review item was identified.		
1. Scope of Program		
Cable connections associated with cables within the scope of license renewal that are external connections terminating at active or passive devices, are in the scope of this AMP. Wiring connections internal to an active assembly are considered part of the active assembly and, therefore, are not within the scope of this AMP. This AMP does not include high-voltage (>35 kilovolts) switchyard connections. The cable connections covered under the Environmental Qualification (EQ) program are not included in the scope of this program.		
1.1. No significant concern or further review item was identified.		
2. Preventive Actions		
This is a condition monitoring program, and no actions are taken as part of this program to prevent or mitigate aging degradation.		
2.1:. No significant concern or further review item was identified.		
3. Parameters Monitored/Inspected		
This AMP focuses on the metallic parts of the connection. The one-time testing verifies that increased resistance of connection due to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation is not an aging effect that requires periodic testing. A representative sample of electrical cable connections is tested. The following factors are considered for sampling: voltage level (medium and low voltage), circuit loading (high load), connection type, and location (high temperature, high humidity, vibration, etc.). The technical basis for the sample selection is documented.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
3.1: No significant concern or further review item was identified.		
4. Detection of Aging Effects		
A representative sample of electrical connections within the scope of license renewal is tested at least once prior to the period of extended operation to confirm that there are no aging effects requiring management during the period of extended operation. Testing may include thermography, contact resistance testing, or other appropriate testing methods without removing the connection insulation, such as heat shrink tape, sleeving, insulating boots, etc. The one-time test provides additional confirmation to support industry operating experience that shows that electrical connections have not experienced a high degree of failures, and that existing installation and maintenance practices are effective. Twenty percent of the population with a maximum sample of 25 constitutes a representative sample size. Otherwise a technical justification of the methodology and sample size used for selecting components for one-time test should be included as part of the AMP's site documentation. As an alternative to thermography or measuring connection resistance of the cable connection sample, for accessible cable connections that are covered with heat shrink tape, sleeving, insulating boots, etc., the applicant may use visual inspection of insulation materials to detect surface anomalies, such as embrittlement, cracking, chipping, melting, discoloration, swelling or surface contamination. When this alternative visual inspection is used to check cable connections, the first inspection is completed prior to the period of extended operation and every 5 years thereafter. The basis for performing only a periodic visual inspection to monitor age-related degradation of cable connections is documented.		
4.1: No significant concern or further review item was identified.		
5. Monitoring and Trending		
Trending actions are not included as part of this AMP because it is a one-time testing or, alternatively, a periodic visual inspection program where the ability to trend inspection results is limited. However, results that are trendable provide additional information on the rate of degradation.		
5.1: No significant concern or further review item was identified.		
6. Acceptance Criteria		
Cable connections should not indicate abnormal temperature for the application when thermography is used; otherwise a low resistance value appropriate for the application when resistance measurement is used. When the visual inspection alternative for covered cable connections is used, the absence of embrittlement, cracking, chipping, melting, discoloration, swelling or surface contamination indicates that the covered cable connection components are not loose.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
6.1: No significant concern or further review item was identified.		
7. Corrective Actions		
If acceptance criteria are not met, the corrective action program is used to perform an evaluation that considers the extent of the condition, the indications of aging effect, and changes to the one-time testing program or alternative inspection program. Corrective actions may include, but are not limited to, sample expansion, increased inspection frequency, and replacement or repair of the affected cable connection components. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.		
7.1: No significant concern or further review item was identified.		
8. Confirmation Process		
As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.		
8.1: No significant concern or further review item was identified.		
9. Administrative Controls		
The administrative controls for this AMP provide for a formal review and approval process. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.		
9.1: No significant concern or further review item was identified.		
10. Operating Experience		
Electrical cable connections exposed to thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, or oxidation during operation may experience increased resistance of connection. There have been limited numbers of age-related failures of cable connections reported. An applicant's operating experience with detection of aging effects should be adequate to demonstrate that the program is capable of detecting the presence or noting the absence of aging effects for effectiveness of another preventive or mitigative AMP. This AMP considers the technical information and guidance provided in NUREG/CR-5643, SAND96-0344, IEEE Std. 1205-2000, EPRI 109619, EPRI 104213, NEI White Paper on AMP XI.E6, Final License Renewal Interim Staff Guidance LR-ISG-2007-02, Staff Response to the NEI White Paper on AMP XI.E6, Licensee Event Report (LER) 361 2007005, LER 3612007006 and LER 3612008006.		

Potential Concern/Inadequacy for Subsequent Renewal	Possible Relevance/Significance for Program Element	Action[1]
Ginna: The staff audit did not look at electrical connector operating experience post license renewal and did not compare the ISG, GALL1 and GALL 2 connector programs. Current applicant programs include thermography to examine metallic connections but the consistency with GALL 2 was not determined. Note that the GALL 2 connection program is a one-time inspection program unless aging mechanisms requiring aging management are identified and existing installation and maintenance practices are shown not to be effective.		
10.1: No significant concern or further review item was identified.		

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Appendix A Supplemental Information

Table A.1: Points of Contact at the Ginna Plant

NRC Staff on Audit

Bennett Brady
Cliff Doutt
Jim Gavula
Allen Hiser
Amy Hull
Seung Min
Abdul Sheikh

NRC Staff at Headquarters

John Burke
Gene Carpenter
Ganesh Cheruvenki
Herman Graves
Bill Holston
Ken Karwoski
Greg Makar
Jim Medoff
Glenn Meyer
Kenn Miller
Greg Oberson
Aloysius Obodoaka

Emma Wong
Matt Yoder

Argonne Support

Omesh Chopra
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Licensee Personnel

Scott Baylor
Michael Canny
Brian Dahl
Michael Fallin
Rod Fett
John Fischer
Mark Fitzsimmons
George Herrick
Kenneth Kemp
Frank Klepacki
David Lovgren
Don Magar
D. Markowski
Mary Ellen McGraw
Andrew Patrzalek
Damon Peters
John Sperr
Walter Tono
Jay Wells
A.Guillermo
Ben John
B.Weaver
K. Connor
M. Bodine

Table A.2: Summary of Ginna AMPs and Corresponding GALL AMPs

GINNA AMP (see NUREG-1786 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	Ginna POC
Aboveground Carbon Steel Tanks (B2.1.1)	XI.M29	Abdul Sheikh	Herman Graves	David Ma	Michael Canny
ASME Section XI, Subsections IWE and IWL Inservice Inspect (B2.1.3)	XI.S1, XI.S2, XI.S4	Abdul Sheikh	Herman Graves	David Ma	Frank Klepacki, Mark Fitzsimmons
ASME Section XI, Subsections IWB, IWC, and IWD Inservice Inspection (B2.1.2)	XI.M1	Allen Hiser	John Burke	Yogen Garud	Frank Klepacki
ASME Section XI, Subsection IWF, Inservice Inspection (B2.1.4)	XI.S3	Abdul Sheikh	Herman Graves	David Ma	Frank Klepacki
Bolting Integrity (B2.1.5)	XI.M18	Jim Gavula	John Burke	Yogen Garud	Frank Klepacki
Boric Acid Corrosion (B2.1.6)	XI.M10	Allen Hiser	Herman Graves	Omesh Chopra	A.Patrzalek
Buried Piping and Tanks (B2.1.8) and (B2.1.7)	XI.M28	Allen Hiser	Glenn Meyer, Bill Holston	Dwight Diercks	M.Canny
Closed-Cycle (Component) Cooling Water System (B2.1.9)	XI.M21	Jim Gavula	Gene Carpenter	Dwight Diercks	R.Hellems, Ken Kemp
Compressed Air Monitoring (B2.1.10)	XI.M24	Jim Gavula	Herman Graves	Dwight Diercks	M.Bodine
Concrete Containment Tendon Pre-stress (B3.3)	X.S1	Abdul Sheikh	Herman Graves	David Ma	R.Bahai
Electrical Cables and Connections Not Subject to EQ (B2.1.11)	XI.E1	Cliff Doutt	Kenn Miller	NA	David Lovgren
Electric Cables Not Subject to EQ Used in Instrumentation Circuits (B2.1.12)	XI.E2	Cliff Doutt	Kenn Miller	NA	David Lovgren

GINNA AMP (see NUREG-1786 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	Ginna POC
Environmental Qualification (B3.1)	X.E1	Cliff Doutt	Kenn Miller	NA	David Lovgren
Fatigue Monitoring (B3.2)	X.M1	Seung Min	Jim Medoff	Omesh Chopra	Walter Tono
Fire Protection (B2.1.13)	XI.M26	Amy Hull	Herman Graves	David Ma	Mary Ellen McGraw, Scott Baylor
Fire Water System (B2.1.14)	XI.M27	Amy Hull	Herman Graves, Ganesh Cheruvenki	David Ma	Mary Ellen McGraw, Scott Baylor
Flow-Accelerated Corrosion (B2.1.15)	XI.M17	Jim Gavula	Gene Carpenter, Aloysius Obodoaka	Yogen Garud	A.Guillermo
Fuel Oil Chemistry (B2.1.16)	XI.M30	Allen Hiser	Gene Carpenter, Aloysius Obodoaka	Dwight Diercks	B.Dahl
Heavy & Light Load (Related to Refueling) Handling Syst (B2.1.18)	XI.M23	Bennett Brady	Glenn Meyer	David Ma	Jay Wells, Don Majar
Inaccessible Medium-Voltage Cables Not Subject to EQ (B2.1.17)	XI.E3	Cliff Doutt	Kenn Miller	NA	David Lovgren
Loose Parts Monitoring (B2.1.19)	XI.M14	Amy Hull	Glenn Meyer,	Yogen Garud	John Sperr, Kenneth Kemp, Jay Wells, Michael Fallin
Neutron Noise Monitoring (B2.1.20)	XI.M15	Amy Hull	Greg Oberson,	Yogen Garud	John Sperr, Kenneth Kemp, Jay Wells, Michael Fallin
One-Time Inspection (B2.1.21)	XI.M32	Jim Gavula	Glenn Meyer	Dwight Diercks	Ken Kemp
Open-Cycle Cooling (Service) Water (B2.1.22)	XI.M20	Jim Gavula	Gene Carpenter	Dwight Diercks	Ben John, M.Zweigle

GINNA AMP (see NUREG-1786 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	Ginna POC
Periodic Surveillance and Preventive Maintenance (B2.1.23)	Plant specific	Bennett Brady	Glenn Meyer	Dwight Diercks	George Herrick, Rod Fett
Protective Coatings Monitoring and Maintenance (B2.1.24)	XI.S8	Amy Hull	John Burke, Herman Graves, Emma Wong, Matt Yoder, Greg Makar	David Ma	Andrew Patrzalek, John Fischer
Reactor Head Closure Studs (B2.1.25)	XI.M3	Seung Min	Greg Oberson	Omesh Chopra	Frank Klepacki
Reactor Vessel Internals (B2.1.27)	XI.M16A	Allen Hiser	Jim Medoff, Ganesh Cheruvenki	Omesh Chopra	J.Wells, R. Marcello, K. Kemp, M.Canny
Reactor Vessel Surveillance (B1.1.28)	XI.M31	Seung Min	Jim Medoff	Dwight Diercks	Damon Peters
Selective Leaching of Materials (B2.1.29)	XI.M33	Bennett Brady	Glenn Meyer	Dwight Diercks	Kenneth Kemp
Spent Fuel Pool Neutron Absorbing Monitoring (B2.1.30)	XI.M22	Allen Hiser	Gene Carpenter, Aloysius Obodoaka, Emma Wong	David Ma	R. Dautel, K. Connor
Steam Generator Tube Integrity (B2.1.31)	XI.M19	Seung Min	Greg Oberson, Ken Karwoski	Dwight Diercks	Jay Wells
Structures Monitoring (B2.1.32)	XI.S5, XI.S6, XI.S7	Abdul Sheikh	John Burke	David Ma	Mark Fitzsimmons
System Monitoring (B2.1.33)	Plant specific	Bennett Brady	Glenn Meyer	Dwight Diercks	Jay Wells, D. Markowski
Thermal Aging Embrittlement of CASS (B2.1.34)	XI.M12	Seung Min	Greg Oberson	Omesh Chopra	Michael Fallin
Thimble Tube Inspection (B2.1.36)	Plant specific	Seung Min	Greg Oberson	Yogen Garud	Jay Wells

GINNA AMP (see NUREG-1786 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	Ginna POC
Water Chemistry Control (B2.1.37)	XI.M2	Amy Hull	Gene Carpenter, Emma Wong	Dwight Diercks	Brian Dahl

NA — Information not available.

Table A.3: Points of Contact at the NMP-1 Plant

NRC Staff on Audit

Bennett Brady
Cliff Doutt
Jim Gavula
Amy Hull
Ata Istar
Bruce Lin
Seung Min
Abdul Sheikh

NRC Staff at Headquarters

John Burke
Gene Carpenter
Ganesh Cheruvenki
Herman Graves
Allen Hiser
Bill Holston

Sandra Lindo-Talin
Jim Medoff
Glenn Meyer
Kenn Miller
Greg Oberson
Aloysius Obodoaka

M. Srinivasan
Gary Stevens
Dave Stroup
Rob Tregoning
Gary Wang
Emma Wong
Matt Yoder

Argonne Support

Omesh Chopra
Dwight Diercks
Yogen Garud
David Ma

Licensee Personnel

John Blasiak
Bill Carter
Pete Collins
Gabe Connor
Bob Corcoran
Roy Corieri
Kelly Dellinger
Brian Felicita
Pat Finnerty
Steve Homoki
Scott Houston
George Inch
Phil Kehoe
Jeff Park
Tim Roche
Bob Saunderson
Brian Shanahan
Jeff Stevenson
Bill Sullivan
Jim Wadsworth
Cheryl Widay-Poindexter
Clark Willett

Table A.4: Summary of NMP-1 AMPs and Corresponding GALL AMPs

NMP-1 AMP (see NUREG-1900 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	NMP-1 POC
10CFR50 Appendix J (B2.1.26)	XI.S4	Ata Istar	Herman Graves	David Ma	Phil Kehoe
ASME Section XI, Subsections IWB, IWC, and IWD, Inservice Inspection (B2.1.1)	XI.M1	Bruce Lin	John Burke	Yogen Garud	Jeff Stevenson
ASME Section XI, Subsection IWE, Inservice Inspection (B2.1.23)	XI.S1	Abdul Sheikh	Herman Graves	David Ma	Jeff Stevenson
ASME Section XI, Subsection IWF, Inservice Inspection (B2.1.25)	XI.S3	Ata Istar	Herman Graves	David Ma	Jeff Stevenson
Bolting Integrity (B2.1.7)	XI.M18	Jim Gavula	John Burke	Yogen Garud	Bob Corcoran
Boraflex Monitoring (B2.1.12)	XI.M22	Bruce Lin	Aloysius Obodoaka, Emma Wong, Allen Hiser	David Ma	Bill Carter
Buried Pipes and Tanks (B2.1.22)	XI.M34	Bruce Lin	Allen Hiser, Glenn Meyer, Bill Holston	Dwight Diercks	Bob Saunderson
BWR Feedwater Nozzle (B2.1.5)	XI.M5	Ata Istar	Gary Wang, Gary Stevens	Omesh Chopra	Jeff Stevenson
BWR Penetrations (B2.1.7)	XI.M8	Seung Min	M. Srinivasan, Greg Oberson	Omesh Chopra	George Inch, Roy Corieri
BWR Reactor Water Cleanup (B2.1.15)	XI.M25	Seung Min	M. Srinivasan, Greg Oberson	Omesh Chopra	Jeff Stevenson
BWR Rod Control Drive Return Line Nozzle (B2.1.37)	XI.M6	Ata Istar	Gary Wang, Gary Stevens	Omesh Chopra	Jeff Stevenson
BWR Stress Corrosion Cracking (B2.1.6)	XI.M7	Seung Min	M. Srinivasan, Greg Oberson	Dwight Diercks	Jeff Stevenson
BWR Vessel ID Attachment Welds (B2.1.4)	XI.M4	Amy Hull	Sandra Lindo-Talin	Omesh Chopra	George Inch

NMP-1 AMP (see NUREG-1900 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	NMP-1 POC
BWR Vessel Internals (B2.1.8)	XI.M9	Bruce Lin	Allen Hiser, Jim Medoff, Ganesh Cheruvenki	Omesh Chopra	George Inch, Roy Corieri
Closed-cycle Cooling Water System (CCCS) (B2.1.11)	XI.M21 A	Jim Gavula	Gene Carpenter, Sandra Lindo-Talin	Dwight Diercks	Tim Roche
Compressed Air Monitoring (B2.1.14)	XI.M24	Bennett Brady	Gene Carpenter	Dwight Diercks	Steve Homoki
Drywell Supplemental Inspection (B2.1.41)	Plant-specific	Abdul Sheikh	Herman Graves	Dave Ma	Jeff Stevenson
Fatigue Monitoring (B3.2)	X.M1	Seung Min	Rob Tregoning, Gary Stevens	Omesh Chopra	Gabe Connor
Fire Protection (B2.1.16)	XI.M26	Amy Hull	Sandra Lindo-Talin, Dave Stroup	Dave Ma	Bill Sullivan, John Blasiak
Fire Water System (B2.1.17)	XI.M27	Amy Hull	Sandra Lindo-Talin, Dave Stroup	Dave Ma	Bill Sullivan, John Blasiak
Flow-Accelerated Corrosion (FAC) (B2.1.9)	XI.M17	Jim Gavula	Aloysius Obodoaka, Glenn Meyer	Yogen Garud	Jim Wadsworth
Fuel Oil Chemistry (B2.1.18)	XI.M30	Bruce Lin	Allen Hiser, Aloysius Obodoaka	Dwight Diercks	Cheryl Widay-Poindexter
Inspection of Overhead Heavy Load and Light Load Handling Systems (B2.1.13)	XI.M23	Bennett Brady	Glenn Meyer, Gary Wang	Dave Ma	Brian Felicita
Masonry Wall (B2.1.27)	XI.S5	Ata Istar	Herman Graves	Dave Ma	Jeff Park
Non-Eq Elec Cables Instr (B2.1.30)	XI.E2	Cliff Doutt	Kenn Miller	NA	Scott Houston

NMP-1 AMP (see NUREG-1900 section)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	NMP-1 POC
Non-Eq Elec Cables/Conn (B2.1.29)	XI.E1	Cliff Doutt	Kenn Miller	NA	Clark Willett
Non-Eq Metallic Conn/Fuse Holders (B2.1.35)	Plant-specific	Cliff Doutt	Kenn Miller	NA	Pat Finnerty
Non-Seq Bus Inspection (B.2.34)	Plant-specific	Cliff Doutt	Kenn Miller	NA	Brian Shanahan
One Time Inspection (B2.1.20)	XI.M32	Jim Gavula	Glenn Meyer	Dwight Diercks	Phil Kehoe
Open-Cycle Cooling Water System (OCCW) (B2.1.10)	XI.M20	Jim Gavula	Gene Carpenter	Dwight Diercks	Pete Collins
Preventive Maintenance (B2.1.32)	Plant-specific	Bennett Brady	Glenn Meyer	NA	Kelly Dellinger
Protective Coating (B2.1.38)	XI.S8	Amy Hull	Emma Wong, John Burke, Matt Yoder, Aloysius Obodoaka	David Ma	Bob Corcoran
Reactor Head Closure Studs (B2.1.3)	XI.M3	Seung Min	Greg Oberson, Gary Wang	Omesh Chopra	Jeff Stevenson
Reactor Vessel Surveillance (B2.1.19)	XI.M31	Seung Min	Jim Medoff, M. Srinivasan	Dwight Diercks	George Inch, Roy Corieri
Water Chemistry Control (B2.1.2)	XI.M2	Amy Hull	Sandra Lindo-Talin, Emma Wong	Dwight Diercks	Cheryl Widay-Poindexter
Selective Leaching (B2.1.21)	XI.M33	Bennett Brady	Glenn Meyer, M. Srinivasan	Dwight Diercks	Phil Kehoe
Structures Monitoring (B2.1.27 and B.1.28)	XI.S5, XI.S6, XI.S7	Abdul Sheikh	John Burke	David Ma	Gabe Connor
System Aging Walkdown (B2.1.33)	Plant-specific	Benet Brady	Glenn Meyer	Dwight Diercks	Tim Roche
Torus Corrosion (B3.3)	Plant-specific	Abdul Sheikh	NA	NA	Jeff Park

NA — Information not available.

Appendix B – H.B. Robinson Steam Electric Plant

Appendix B **Archive of Information from Worksheets Used during Non-regulatory Audit at H. B. Robinson Steam Electric Plant, Unit 2 (RNP) to Evaluate GALL Rev. 2 AMPs for Possible Subsequent License Renewal**

The verbatim text of the relevant GALL, Rev. 2, AMPs is included in each of the following worksheets; all text in blue is directly transcribed from GALL, Rev. 2. The source of information in each line item that is based on the visits to RNP is identified in the table; all remaining line items are the result of ANL's general review of the AMP and the draft NRC AMP audit report. Audit participants and documents reviewed for the audit are included at the end of Appendix B in Supplemental Information/

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Contents

Audit Worksheet To Gather Information and Perform a Preliminary Evaluation of the AMP for Subsequent Renewal (Jan. 8-9, 2013)

Plant H. B. Robinson Steam Electric Plant, Unit 2 – known as Robinson Nuclear Plant (RNP) per LRA SER NUREG-1765

The objective of this audit is to gather available information from:

(a) The licensee's implementation of the AMP,

(b) Relevant operating experience,

(c) Associated nonconforming conditions,

(d) Licensee assessments, and

(e) Any other input gathered by the audit team – to make a preliminary evaluation about the associated GALL Report AMP (or the plant-specific AMP if it should be considered for generic application) for use in the subsequent license renewal time frame (long term operation, LTO, from 60 – 80 years).

A recommended approach is to:

(a) Examine the AMP Bases document to identify changes to the AMP element content that has evolved since AMP implementation;

(b) Perform a high level review of the AMP and implementing procedure(s) to identify what content has changed based on plant-specific and industry operating experience (OE) since AMP implementation;

(c) Obtain licensee self-assessments and corrective actions related to AMP implementation and identify and document any changes made to the AMP, including the applicant's basis for the change that resolved any associated findings;

(d) Perform a sample key word search (similar to an AMP audit) of the licensee condition report/corrective action report database to identify potential plant specific or industry operating experience (including recurring OE) that could impact the AMP elements or implementation.

(e) Evaluate the above data to identify open items or lessons learned to that should be considered for the GALL AMP for subsequent license renewal and LTO (60 to 80 years).

The objective of the audit is **NOT** to: (i) inspect the proper implementation of the current AMP, (ii) verify the conformance of the AMP with the approved LRA, or to (iii) assess the delta between the AMP and GALL Revision 2.

1. Preliminary Evaluation of the AMP Adequacy for Subsequent Renewal:

Based on implementation results, operating experience, non-conforming conditions, and other licensee assessments, results of the audit indicate the AMP is:

☐ Appears adequate as-is for subsequent license renewal

☐ Appears generally adequate for subsequent license renewal but with an item of concern

☐ Appears inadequate for subsequent license renewal application.

2. Potential Items of Concern or Inadequacies of the AMP:

The following potential items of concern or inadequacies of the AMP for subsequent license renewal will be documented in the following table.

- The item of concern or inadequacy that may affect the element(s) of the AMP or implementation for subsequent license renewal.
- Specific unexpected aging degradation which may affect long term operation.
- Potential subsequent license renewal aging management concerns such as testing frequency, test methods, and accessibility issues.
- Adverse plant specific or industry operating experience indicating the need to adjust the AMP for subsequent license renewal
- Differences (including additions, deletions, and changes) between the AMP element (since implementation of the AMP) and the current AMP element that could affect the adequacy of the AMP for subsequent license renewal should be identified, and the basis documented.
- If, for the first renewal, the licensee took any exceptions, or instituted any enhancements, that affect the adequacy of the AMP for subsequent license renewal.

The remaining sections of the RNP audit worksheets for the AMPs that were reviewed during the audit are presented below.

B.1 ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD Program (LRA Section B.2.1)

Associated GALL Report AMP: **2001 GALL Report, XI.M1 ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD**

B.1.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.2.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected. If there is an issue, include pertinent text from the program description.	No significant issue or further review item was identified.
1. Scope of Program	The RNP AMP B.2.1 is consistent, with no deviation, with the associated GALL AMP XI.M1: ASME Section XI, ISI, Subsections IWB, IWC and IWD. The AMP is credited for aging management of selected components in several systems at RNP. The aging effects/mechanisms of concern listed in the RNP LRA are: (a) Cracking due to SCC, (b) Loss of Pre-load due to Stress Relaxation and Irradiation Creep, (c) Loss of Material due to Wear, Aggressive Chemical Attack, Crevice Corrosion, General Corrosion, and Pitting Corrosion, and (d) Reduction of Fracture Toughness due to Thermal Embrittlement. The RNP ISI program also ensures early detection of cracking due to thermal fatigue in the pressurizer surge line through the routine performance of volumetric examination of the surge line welds as stated in the Thermal Fatigue TLAA. The RNP Fourth Ten-Year Interval ASME Section XI Inservice Inspection Program began on February 19, 2002; and the Subsections IWB, IWC and IWD portion of the program includes all portions of the Class 1, 2, and 3 systems. The Fourth Ten-Year Interval Program was developed and prepared to meet the ASME Code, Section XI, 1995 Edition, 1996, Addenda.	In the evaluation of the ASME Section XI, Subsection IWB, IWC and IWD Program against the program elements of the GALL Report, exceptions to Code requirements that have been granted by approved relief requests were not considered exceptions to the GALL criteria. [SER, NUREG-1785]: One of the license conditions required that the future inspection activities identified in RNP (updated) UFSAR Supplement be completed prior to the PEO. According to the relief request, RR-23, (ADAMS ML110330085), RNP is considering an alternative to the requirement of IWB-2412, Inspection Program B, that volumetric examination of essentially 100% of reactor vessel pressure retaining, Examination Category B-A and B-D welds, be performed once each ten-year interval. The alternative is for the interval to be 20 years (i.e., no inspection for the 4th ISI inspection, and only one, around 2021, during the PEO). The RNP "Fifth Ten-Year Interval Inservice Inspection Program" is based on the requirements of the ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, 2007 Edition with 2008 Addenda. It includes requests for relief from ASME Code requirements, as described in

Program Element	Element of Licensee's AMP (LRA Section B.2.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		ADAMS ML12082A009. Check the status and confirm the adequacy of these new plan changes and relief requests to be operative in the PEO.
2. Preventive Actions		No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected		**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Does this AMP include the high strength closure bolts, regardless of code classification, as part of volumetric examination in accordance with the ASME Code Section XI, Table IWB-2500-1, Examination Category B-G-1?
4. Detection of Aging Effects		No significant issue or further review item was identified.
5. Monitoring and Trending		No significant issue or further review item was identified.
6. Acceptance Criteria		No significant issue or further review item was identified.
7. Corrective Actions		No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The ISI AMP is continually upgraded based on the industry experience and related research. Actions are taken under RNP's Corrective Actions	NO ACTION

Program Element	Element of Licensee's AMP (LRA Section B.2.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Program (CAP) to initiate the ISI AMP improvements.	

B.1.4. Other concern related to the aging management for the subsequent license renewal period

Does this AMP include the high strength closure bolts, regardless of code classification, as part of volumetric examination in accordance with the ASME Code Section XI, Table IWB-2500-1, Examination Category B-G-1?

B.1.5. Documents Reviewed during the Audit

1. ASME Section XI, Inservice Inspection (ISI), Subsections IWB, IWC, and IWD Program.
2. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
3. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
4. Inservice Inspection Program for the Fifth Ten-year Interval, RNPSEP, Unit 2. (Serial RNP RA-12/0023).
5. LRA, RNP Table 3.6-2 Electrical/I&C Aging Management Evaluation That are Different From or Not Addressed in the GALL Report
6. MRP-227-A
7. MRP-228
8. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
9. RR-23, Request for Relief from ASME Boiler and Pressure Vessel Code, Section XI, for the Fourth Ten-year ISI Program Interval, HBRSEP, Unit 2. (Serial RNP RA-11-002), ADAMS ML110330085, February 2010.

B.1.6. Summary

Robinson LRA Section B.2.1 summarizes RNP's implementation of the associated GALL AMP XI.M01 – ASME Section XI, ISI, Subsections IWB, IWC and IWD (Rev. 0 of GALL Report, 2001). The RNP AMP B.2.1 states that it is consistent, with no deviation, with the

associated GALL AMP XI.M1. Staff's SER (NUREG-1785) confirmed the consistency of RNP's AMP B.2.1 with the associated GALL AMP XI.M01, and staff's Post-approval Site Inspection for License Renewal Inspection Report (IR 201008) confirmed that RNP had completed necessary action on its related commitment prior to the start of the PEO.

The AMP B.2.1 is credited for aging management of selected components in several systems at RNP. The aging effects/mechanisms of concern listed in the RNP LRA are: (a) Cracking due to SCC, (b) Loss of Pre-load due to Stress Relaxation and Irradiation Creep, (c) Loss of Material due to Wear, Aggressive Chemical Attack, Crevice Corrosion, General Corrosion, and Pitting Corrosion, and (d) Reduction of Fracture Toughness due to Thermal Embrittlement. The RNP ISI program also ensures early detection of cracking due to thermal fatigue in the pressurizer surge line through the routine performance of volumetric examination of the surge line welds as stated in the Thermal Fatigue TLAA.

In its evaluation of the ASME Section XI, Subsection IWB, IWC and IWD Program against the program elements of the GALL Report, exceptions to Code requirements that have been granted by approved relief requests were not considered by RNP to be exceptions to the GALL criteria. According to the relief request, RR-23, (ADAMS ML110330085), RNP is considering an alternative to the requirement of IWB-2412, Inspection Program B, that volumetric examination of essentially 100% of reactor vessel pressure retaining, Examination Category B-A and B-D welds, be performed once each ten-year interval. The alternative is for the interval to be 20 years (i.e., no inspection for the 4th ISI inspection, and only one, around 2021, during the PEO).

During its audit (January 2013), the staff reviewed the status of RNP's ISI program results of implementation of the GALL AMP XI.M01 and inquired about RNP's plan including any modifications for the PEO to its LRA AMP B.2.1. RNP noted that its AMP is consistent, with no deviation, with the GALL AMP XI.M01, and that its Fourth Ten-Year Interval of ASME Section XI ISI (which began in early 2002) was implemented to meet the ASME Code, Section XI, 1995 Edition, 1996 Addenda. RNP noted that its Fifth Ten-Year Interval is based on the requirements of 2007 Edition with 2008 Addenda of the Code, and it includes requests for relief from ASME Code requirements, as described in ADAMS ML12082A009. RNP also noted that it is evaluating a possible modification of the actual inspection sub-intervals during the PEO, within the Code allowable timing, to better match (or align with) its outage schedule, including related considerations for the pressure tests. This would appear to be unique at this time to RNP.

The staff asked if RNP's program implementation has included any risk-informed inspection basis, or has any plans to do so. RNP stated that its ISI program has not used any risk-informed basis yet and it has no currently planned action in this regard.

The staff also enquired about changes or updates to RNP's ISI activity related to its Nickel-base components. RNP noted that it replaced the UT with phased array as the technique for testing vessel nozzles, finding some weld indications; these were all embedded (not ID-connected or surface breaking) indications. It was not clear or confirmed if these flaws would be growing with time, although the ISI program will meet the follow-up Code inspection requirements, and if this OE had implications for, or how it was shared with, other sites and plants.

The staff discussed considerations related to the inspections on socket-welded locations at RNP, and whether any improvements or developments for use of UT in these cases were made at RNP. RNP noted that while no UT related work on socket welds was available at RNP it will continue to follow the industry developments in related enhancements. RNP also stated that its inspection program for socket welds is staggered with adequate coverage of these locations through the inspection interval, but with essentially random selection. The staff suggested that the inspection program is likely to benefit if the sample selection included considerations of susceptibility and significance of socket weld locations.

With regard to the examinations augmenting the ISI program for the Fifth Ten-Year Interval the RNP basis notes that, when planning for inspections associated with MRP-227-A & MRP-228 on the Reactor Vessel Internals Aging Management Program (future), consideration should be given for the optimum scheduling sequence and combination for inspections, such as combining visual examinations with ultrasonic examination of bolting in the same area of the vessel, in order to minimize radiation dose to the examination personnel and reduce inspection task durations.

From the review of augmented ISI program at RNP the staff notes that several items have no direct links to either an ASME Code document (such as a Code Case) or a regulatory document for basis, requirements, or implementation; for example: sampling of piping to perform ultrasonic examination, for thermal fatigue, on lines that are normally stagnant and nonisolable, and for ultrasonic examination of the RHR flow mixing tee and downstream piping.

Procedurally, RNP implementation of this AMP uses three separate programs: ISI ASME Section XI Repair/Replacement, ISI – Pressure Testing, and ISI – Weld Examinations, which it considered to be more effective to assure meeting the needs of regulatory requirements, program reviews, and adequate resources. RNP noted that its program is continually upgraded based on industry experience and research, and its plant-operating experiences are shared corporate-wide through regular peer group meetings.

The staff asked if there were any documents that show if, and what, CAP based improvements to the ISI program were made at RNP; RNP indicated that there were none. RNP noted that it performs periodic self-assessment of this AMP and that the last assessment was about three years old. The latest self-assessment, November 2012, for license renewal programs, was a quick-hit type that did not include the ISI AMP review.

B.2 Water Chemistry Program (LRA Section B.2.2)

Associated GALL Report AMP: **2001 GALL Report, XI.M2 Water Chemistry**

B.2.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.2.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	This is an existing program which is credited for mitigating the aging effects of loss of material due to erosion, fretting, crevice, general, galvanic, and pitting corrosion, as well as cracking and fouling of heat transfer surfaces. The aging effects are mitigated by controlling the chemical species that cause the underlying aging mechanisms. Station chemistry procedures specify sampling scope, acceptance criteria, frequency, and corrective actions for sample results not within acceptance criteria.	No significant issue or further review item was identified.
1. Scope of Program	The RNP LRA states that the Water Chemistry Program (B.2.2) differs from GALL Section XI.M2, Water Chemistry, in the following respects: • An aging mechanism identified in the RNP AMR was not identified in GALL, namely Loss of Heat Transfer Effectiveness due to Fouling of Heat Transfer Surfaces). • The RNP Water Chemistry Program implements later revisions of the EPRI guidelines for Primary and Secondary Water Chemistry than listed in GALL, Rev. 0. The RNP Water Chemistry Program is based on the current, approved revisions of EPRI Guidelines as prescribed by NEI 97-06.	The Robinson Operating Manual CP-001, Rev. 111 references the most recent revisions of the EPRI PWR Water Chemistry Guidelines, as follows: Primary: Revision 6 (EPRI 1014986), 2007 Secondary: Revision 7 (EPRI 1016555), 2009 A revision of the 2007 (Rev. 6) edition of the Primary Water Chemistry Guidelines is currently underway and is to be published in the Fall of 2013. Note guidance given in GALL, Rev. 2, p. XI.3. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Some plants take exceptions to the GALL recommendation for monitoring of hydrogen peroxide, because accurate measurement of this chemical is extremely difficult, due to its rapid decomposition in the sample lines. As an alternative, they monitor the molar ratio of hydrogen to oxygen, consistent with EPRI TR-

Program Element	Element of Licensee's AMP (LRA Section B.2.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		103515, Rev. 2. The Robinson Operating Manual CP-001, Rev. 111 (paragraph 8.7.1) appears to indicate that this is the practice at Robinson.
2. Preventive Actions	(Robinson AMP Program Element 2 described as consistent with GALL)	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	(Robinson AMP Program Element 3 described as consistent with GALL)	The Robinson 2011 Secondary Chemistry Self-Assessment noted several deficiencies in the plant procedures where the procedure requirements were not in agreement with the Guidelines, or where Guidelines' requirements were not fully implemented in the procedures. In addition, there were also several potential enhancements noted in these same procedures, which would clarify and better define the requirements of the EPRI Guidelines. Finally, there were several potential enhancements to be considered for inclusion into the procedures.
4. Detection of Aging Effects	(Robinson AMP Program Element 4 described as consistent with GALL.) In its response to RAI B.2.2-3, the applicant stated that a one-time inspection would be performed on selected components at susceptible locations covered under the Water Chemistry Program. Inspections will include internal visual or volumetric examinations, to determine if loss of material or cracking has occurred. The results of these inspections will be used to assess the condition of the components in question and reviewed against assumptions made regarding the effectiveness of water chemistry controls in support of license renewal.	
5. Monitoring and Trending	(Robinson AMP Program Element 5 described as consistent with GALL)	Robinson Operating Manual CP-001, Rev. 111 states that the plant maintains a Chemistry Data Management System (CDM), which is an electronic database used for storing, limit checking, reporting, and trending chemistry analyses. This is considered good practice and is probably a common practice now.

Program Element	Element of Licensee's AMP (LRA Section B.2.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
6. Acceptance Criteria	(Robinson AMP Program Element 6 described as consistent with GALL)	No significant issue or further review item was identified.
7. Corrective Actions	(Robinson AMP Program Element 7 described as consistent with GALL)	No significant issue or further review item was identified.
8. Confirmation Process	(Robinson AMP Program Element 8 described as consistent with GALL)	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	(Robinson AMP Program Element 9 described as consistent with GALL)	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	Robinson operating experience with respect to water chemistry control for the period 1989 through 1999 is described in RNP-L/LR-0600 ("Aging Management Program, Water Chemistry Program, Rev. 11"), Section 6.3. A total of 82 condition reports were found, most of which dealt with excursions in chemical species exceeding applicable guidelines. No significant events were cited, and an independent search of LERs through 2012 also found no significant events related to water chemistry.	Appendix A Robinson implemented power uprates in 1979 and 2002.

B.2.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.2.5. Documents Reviewed during the Audit

1. Assessment 447056 (nonpublic), Robinson Secondary Chemistry Self-Assessment, 2011.

2. CP-001, Rev. 111, Plant Operating Manual, Vol. 5, Part 3, CP-001, Chemistry Monitoring Program.
3. EPRI TR-103515, Rev. 2.
4. EPRI 1014986, Rev. 6, EPRI PWR Water Chemistry Guidelines, 2007.
5. EPRI 1016555, Rev. 7, EPRI PWR Water Chemistry Guidelines, 2009.
6. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
7. NEI 97-06, Rev. 3, Nuclear Energy Institute, Steam Generator Program Guidelines, January 2011.
8. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
9. RNP-L/LR-0600 (nonpublic), Rev. 11, Aging Management Program, Water Chemistry Program, 2004.

B.2.6. Summary

Robinson implements this program through its AMP B.2.1.2 “Water Chemistry Program.” The Robinson LRA states that its program is consistent with GALL, Revision 0 AMP XI.M2 (“Water Chemistry”) with the following two exceptions:

- An aging mechanism identified in the RNP AMR was not identified in the GALL Report (Loss of Heat Transfer Effectiveness due to Fouling of Heat Transfer Surfaces). **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Consider adding to AMP and AMR line-items.

- The RNP Water Chemistry Program implements later revisions of the EPRI guidelines for Primary and Secondary Water Chemistry than recommended in the GALL Report. The RNP Water Chemistry Program is based on the current, approved revisions of EPRI Guidelines as prescribed by NEI 97-06.

Both of these exceptions were found to be acceptable in the Robinson SER (NUREG-1785). The efficacy of the Robinson Water Chemistry Program is verified through its One-Time Inspection Program B.4.4.

During the audit, Robinson stated that it presently follows the most recent EPRI water chemistry guidance, namely Revision 6 (EPRI 1014986, dated 2007) for primary water and, Revision 7 (EPRI 1016555, dated 2009) for secondary water. The auditors noted that a revision of the guidance for primary water chemistry is currently being prepared by EPRI and is to be published in the fall of 2013. Robinson stated this updated guidance would be incorporated into their program, though this timing could be extended somewhat by an intervening refueling outage.

In response to a question, Robinson stated that the plant maintains a hydrogen concentration in the primary system, in accordance with EPRI primary water chemistry guidelines, to control the corrosive attack of components in contact with the primary coolant, and the H:O molar ratio is monitored. Robinson also stated that they plan to implement Zn additions to the primary system, starting two outages in the future (around 2016), to control background radiation levels.

Robinson also plans to make changes to the primary water pH specifications in the fall of 2015, as a part of the Zn additions program. These changes entail going from the present “modified pH” regime, as described in the EPRI primary water chemistry guidelines, to a “coordinated pH” or constant elevated pH program. Robinson currently utilizes a regime with a minimum pH of 6.9 and a maximum pH of 7.4, with maximum lithium (as LiOH) level of 3.5 ppm and 2.2 ppm in the modified range. The proposed "coordinated" pH program maintains an elevated constant pH 7.1, with a maximum lithium of 4.5 ppm, for up to four effective full-power days (EFPD), followed by a maximum target of 3.5 ppm lithium, to establish and maintain a constant pH of 7.1 for the remainder of the cycle. The principal purpose of these changes is to limit corrosion and activation product formation in the primary water system.

The auditors also questioned the effects of the power uprates in 1979 and 2002 on water chemistry and iron transport in particular. The 1979 uprate predated the experience of the Robinson audit participants, but they stated that the 2002 uprate was accompanied by a reduction in iron transport in the secondary system.

It was noted during the audit that Robinson maintains a Chemistry Data Management System (CDM), which is an electronic database used for storing, limit checking, reporting, and trending chemistry analyses. This was identified in the audit as a good practice.

The Robinson 2011 Secondary Chemistry Self-Assessment noted several deficiencies in the plant procedures, where the procedure requirements were not in agreement with the Guidelines, or where Guidelines’ requirements were not fully implemented in the procedures. In addition, there were also several potential enhancements noted in these same procedures, which would clarify and better define the requirements of the EPRI Guidelines. Finally, there were several potential enhancements to be considered for inclusion into the procedures. All of these were characterized as “minor” deficiencies, and the Robinson personnel stated that they were being actively addresses. The self-assessment stated that all control parameters were present in the Water Chemistry Program documentation, as required by the EPRI Guidelines.

Robinson stated that the water chemistry monitoring program undergoes continuing revisions, and has been revised numerous time since license renewal in 2004. They are currently using Revision 111.

B.3 Reactor Head Closure Studs Program (LRA Section B.2.3)

Associated GALL Report AMP: **2001 GALL Report, XI.M3 Reactor Head Closure Studs**

B.3.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Worksheet table evaluating the 10 elements of the AMP to identify items of concerns or inadequacies was not prepared because this AMP was rated as low priority in the audit plan.

B.3.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.3.5. Documents Reviewed during the Audit

1. ASME Section XI, Inservice Inspection (ISI), Subsections IWB, IWC, and IWD Program.
2. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
3. RG 1.65

B.3.6. Summary

The Robinson Nuclear Plant (RNP) AMP B.2.3 Reactor Head Closure Studs Program is an existing program, credited for managing the aging effects on the reactor head closure studs and stud components for (a) the potential loss of preload due to stress relaxation and (b) loss of material due to wear. The closure studs, nuts, and washers are included within the scope of the program. The program is implemented through the ASME Section XI Inservice Inspection (ISI), Subsections IWB, IWC, and IWD Program (described in calculation RNP-L/LR-0606), which monitors the condition of the closure studs and stud components in accordance with Table IWB-2500-1. The licensee noted that although AMP B.2.3 is not committed to regulatory guide, RG 1.65, the reactor head closure stud fabrication details and

preventive measures are consistent with the recommendations of RG 1.65. The licensee further noted that the RNP Reactor Head Closure Studs AMP B.2.3 (described in calculation RNP-L/LR-0619) is consistent with the GALL AMP XI.M3 Rev. 0.

The reviewers noted that the guidance for preventive measures has been revised in GALL AMP XI.M3 Rev. 2, and is different from that of XI.M3 Rev. 0. For example, Rev. 2 recommends using bolting material for closure studs that has actual yield strength less than 1034 MPa (150 ksi) instead of material tensile strength less than 1172 MPa (170 ksi). RNP has not reviewed the yield strength of the closure studs material, and agreed to check the material specifications to confirm whether the material yield strength is also within the preventive actions guidance of AMP XI.M3 in GALL Rev. 2.

The reviewers noted that the aging effects/mechanisms of concerns included in the program description of the RNP AMP B.2.3 did not include crack initiation and growth due to SCC or IGSCC, or coolant leakage from reactor head closure bolting. However, the RNP program described in Section 6.2.1 of calculation RNP-L/LR-0619 states that the aging effects/mechanisms of concern are as follows: (a) Loss of preload due to stress relaxation, loss of material due to wear, and cracking due to SCC. In addition, Table 6.2-1, Element 4, Detection of Aging Effects, of calculation RNP-L/LR-0619, states that the RNP ASME Section XI ISI program described in calculation RNP-L/LR-0606 uses a combination of magnetic particle, ultrasonic and visual examinations of the studs, nuts, washers and stud holes to detect discontinuities and flaws. In addition, visual VT-2 examination of the entire reactor coolant pressure boundary, to detect evidence of leakage from pressure-retaining components, is routinely performed during pressure tests required by the ASME Section XI ISI program.

Therefore, the RNP Reactor Head Closure Studs Program B.2.3 does include ISI to detect crack initiation and growth due to SCC or IGSCC, as well as VT-2 examination to detect coolant leakage from reactor head closure bolting. The program description, however, seems to be incomplete and misleading. The reviewers enquired about the reason why the RNP program B.2.3 also included loss of preload due to stress relaxation as an aging effect/mechanism of concern. RNP stated that there has been no OE related to stress relaxation. It is not clear why this aging effect/mechanism was included in the RNP program.

The RNP LRA states that the fourth 10-year inspection interval plan was developed and prepared to meet the ASME Code, Section XI, 1995 Edition, 1996 Addenda. The reviewers noted that the ISI requirements that will be followed during the next 10-year interval are in accordance with ASME Code 2007 Edition, 2008 Addenda. The last inspection was performed during reactor outage RO-27.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): The inspection interval is likely to be adjusted to ensure that the last inspection and the end of the current license occur at the same time. Note that for the reactor head closure studs, the inspection requirements are significantly different for 1995 Edition with 1996 Addenda than those for 2007 Edition with 2008 Addenda. The former requires both volumetric and surface examination of the studs when removed, while the latter only require volumetric examination.

No condition reports (CRs) documenting deficiencies or problems with closure studs or stud components were found. There have been only two instances of stud or stud component deficiencies. In May 1992, thread damage was detected by visual examination on stud 41, which was repaired and determined to be acceptable. In April 2001, UT of stud 29 showed a recordable indication; the stud was replaced. RNP noted that the repair of closure head studs and nuts does not involve grinding.

RNP noted that the AMP basis documents include a broad description of what needs to be done to implement the AMP. This information is evaluated to prepare a list of requirements for the program. An “implementation tracking” program verifies that these requirements are being followed. In addition, self-assessments are performed periodically; the period for ASME Section XI ISI program is every 4 years. The results of such assessments are captured in the corrective action program.

RNP also noted that power uprates have had no effect on this AMP. In addition, any design change in the reactor coolant pressure boundary components is evaluated and its impact on operating procedures or AMPs is addressed.

B.4 Boric Acid Corrosion (LRA Section B.3.2)

Associated GALL Report AMP: **2001 GALL Report, XI.M10 Boric Acid Corrosion**

B.4.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The RNP AMP B.3.2 consists of (a) visual inspections of external surfaces potentially exposed to borated water leakage, (b) timely discovery of leak path and removal of boric acid residues, (c) assessment of the damage, and (d) follow-up inspections for adequacy of corrective actions. The program was implemented in response to NRC Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants." The aging effects/mechanisms of concern include (i) loss of material due to aggressive chemical attack and general, crevice, and pitting corrosion, and (ii) loss of mechanical closure integrity due to loss of material from aggressive chemical attack. Its scope was originally limited to carbon steel SSCs that were exposed to leaking coolant from the reactor coolant pressure boundary. As a result of its license renewal review, the program scope has been enhanced to (1) ensure that mechanical, structural, and electrical components which are within the scope for license renewal are covered, and (2) identify additional areas in which components may be susceptible to exposure from boric acid (e.g., containment, auxiliary, and spent fuel buildings).	The original program (before license renewal) is described in RNP procedure documents PLP-040 Rev. 11, "Boric Acid Corrosion Control Program, Status" and OST-051 Rev. 29, "Reactor Coolant System Leakage Evaluation." The leakage evaluation is performed every 72 hours during steady state operation and within 12 hours after reaching steady state. At present, the PLP-040 procedure has been superseded by EGR-NGGC-0207 Rev. 3, "Boric Acid Corrosion Control."
1. Scope of Program	Consistent with GALL Rev. 0 AMP, the RNP program B.3.2 provides systematic measures to ensure that	Note that sources of borated water other than from the reactor coolant system and components not part of the

Program Element	Element of Licensee's AMP (LRA Section B.3.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	corrosion caused by leaking borated reactor coolant does not lead to degradation of the leakage source or adjacent structures and components, and assurance that the reactor coolant pressure boundary will have an extremely low probability of abnormal leakage, rapidly propagating failure, or gross rupture. The RNP components that are included in this program and address in GALL report are listed in Attachment 1 of RNP-L/LR-0601, Rev. 5. In addition, the RNP program includes components that are either not addressed in GALL or not listed as being susceptible to boric acid corrosion (BAC). These components are listed in attachment 2 of RNP-L/LR-0601, Rev. 5.	reactor coolant pressure boundary were not specifically within the scope of the RNP original B.3.2 program. The program also did not address aluminum components. The enhanced program shall include all mechanical, structural, and electrical components. The program shall also identify all areas in which components are susceptible to exposure from boric acid (e.g. containment, auxiliary, and spent fuel buildings. *With these enhancements, the RNP program B.3.2 will be consisted with GALL Rev. 2 AMP XI.M10.* However, *RNP's program does not clarify whether there are any inaccessible areas that are considered susceptible to BAC.* **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Consideration of inaccessible areas.
2. Preventive Actions	RNP procedure PLP-040 requires, "When leakage is discovered, the leak/spray path shall be investigated, removing insulation as necessary, to determine the extent of any component degradation." The leakage evaluation procedure OST-051 provides frequent monitoring for leakage. In addition, the leakage test procedure OST-052 and inspection procedure OST-053 provide assurance that leakage will be detected following maintenance. An operating mode change EST-083 - In-service Inspection Pressure Testing of Reactor Coolant System (Refueling Shutdown Interval) also provides periodic inspections. As quoted in RNP-L/LR-0601, procedure PLP-040 section 6.5 requires, "These leaks must be repaired or be evaluated (and documented) to assure continued reactor coolant pressure boundary integrity… " Section 7.6.1 states, "When leakage has been identified, Maintenance may request the Mechanical Systems Unit to determine the significance of the leakage problem, determine	**ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): The use of "seal caps" to contain borated water leakage is of great interest. Recently, License Renewal RAIs for a number of PWRs were made, asking the applicants to describe how they are age managing components enclosed within the caps (particularly bolting) that are exposed to a borated water environment. In response, applicants have committed to removing these devices so the bolting can be inspected.

Program Element	Element of Licensee's AMP (LRA Section B.3.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	appropriate corrective measures, and to coordinate resolution/repairs." The corrective measures may include modifications in the design or operating procedures as appropriated, as well as containment of the leak away from components susceptible to BAC.	
3. Parameters Monitored/ Inspected	As quoted in RNP-L/LR-0601, procedure PLP-040 contains the general requirement, "Discoloration, staining, boric acid residue, and other evidence of leakage on insulation surfaces and the surrounding area shall be given particular consideration as evidence of component leakage. If evidence of leakage is found, removal of insulation to determine the exact source may be required."	
4. Detection of Aging Effects	RNP-L/LR-0601 states that PLP-040 is the program written to satisfy GL 88-05. As described above, it includes guidelines for locating small leaks, conducting examinations, and performing engineering evaluations as described in GL 88-05.	Based on the NRC SER, effective implementation of these program procedures was demonstrated during RO-20 in response to the identification of a CRM canopy seal weld leak. The program procedure outlines specific activities and inspection boundaries. In addition, licensee's letter dated Sept. 4, 2001, stated that during RO-20 in May 2001, it performed: (a) Extensive visual examinations of the RV head, (b) Removal of the RV head shroud and insulation for these visual examinations resulting in the performance of a bare metal visual examination, and (c) Cleaning of the RV head in support of these visual examinations.
5. Monitoring and Trending	RNP-L/LR-0601 states, "In general, all plant personnel should recognize borated system leakage and initiate work requests for repair." Also, PLP-040 Section 7.1 states, "This program is based on walkdown inspections during refueling outages, and during normal opening of the Reactor Coolant system during maintenance activities,	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	trending daily RCS leakage evaluations, and monitoring for leakage during power operations." In addition, RCS leakage evaluation is performed every 72 hours during steady state operation and within 12 hours after reaching steady state operation (OST 051). If unidentified leakage is greater than 0.20 gpm an investigation is started immediately. RNP-L/LR-0601 states that TMM-104 provides guidelines to inspect for indications of BAC. This procedure requires walkdowns be scheduled and performed so the entire system is fully walked down within one operating cycle.	
6. Acceptance Criteria	PLP-040 requires maintenance work requests be initiated upon discovery of leakage. This procedure also describes the requirements for examination, evaluation, and corrective measures.	No significant issue or further review item was identified.
7. Corrective Actions	PLP-040 Section 1.0 states, "This procedure specifies the measures necessary to comply with GL 88-05. The intent is to detail the program for identification, evaluation, repair, and prevention of BAC of carbon steel components forming the reactor coolant primary pressure boundary." Section 7.6.1 further states, "When leakage has been identified, Maintenance may request the Mechanical Systems Unit to determine the significance of the leakage problem, determine appropriate corrective measures, and to coordinate resolution/repairs." Section 7.6.2 requires, where leakage is significant or boron corrosion is indeterminate, a Condition Reported be initiated.	N/A – this is boilerplate and items of concern are not expected for this element.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		RNP-L/LR-0601 Section 3.0 "Revision History," item # 4 for Rev. 5 states that Table 6.2-1 has been revised to indicate that PLP-040 has been superseded by EGR-NGGC-0207.

Program Element	Element of Licensee's AMP (LRA Section B.3.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		However, as discussed in this worksheet, the description of each of the ten program elements in Table 6.2-1 of RNP-L/LR-0601 refers to procedure PLP-040. In addition, the discussions of program element 7 "Corrective Actions" states that the intent of the program specified in PLP-040 Section 1.0 is to provide the details for identification, evaluation, repair, and prevention of BAC of carbon steel components forming the reactor coolant primary pressure boundary. As discussed above in the Program Description and Scope of Program, the RNP AMP has been enhanced to include not only carbon steel components, but also all mechanical, structural, and electrical components within the scope for license renewal or components that may be exposed to boric acid (e.g., containment, auxiliary, and spent fuel buildings). **GLOBAL ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): *This example indicates that for subsequent operation, the program element 9, Administrative Controls should be revised to include guidance, which ensures that when an AMP is revised/updated all site-specific procedure documents associated with that AMP are also revised/updated accordingly.*
10. Operating Experience	RNP-L/LR-0601 Section 6.3.1 "Self-Assessment AR-68113," examined the effectiveness of the RNP BACC programs, and identified any major deficiencies in minimizing the potential for corrosion damage to SSCs based upon the events at Davis-Besse. It provided the following summary: The programs are providing assurance that the potential for corrosion from boric acid corrosion is minimized. The plants are demonstrating an increasing intolerance for	A Self-Assessment for BACCP Leak Trending Review for RNP was performed in 2011. A November 26 – 28, 2012 self-assessment mentioned that there was a gap-analysis for GALL Rev 0 vs GALL Rev 2. Calculation RNP-L/LR–0601 states "Operating Experience is addressed for industry boric acid corrosion related events via NRC Bulletins, Information Notices, Generic Letters, and EPRI documents. The RNP Boric Acid Corrosion Program is continually upgraded based on industry

Program Element	Element of Licensee's AMP (LRA Section B.3.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	leaving active RCS leaks in service before startup. Housekeeping issues rather than potential breaches of the pressure boundary.	experience and research (CAP-NGGC-0202, Operating Experience Program, Reference 5.12).

B.4.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.4.5. Documents Reviewed during the Audit

1. CAP-NGGC-0201-5-18, Rev. 18, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, Nov. 26–28, 2012.
2. CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.
3. EGR-NGGC-0207 (nonpublic), Rev. 3, Corporate procedure for Boric Acid Corrosion Control.
4. EST-083, In-service Inspection Pressure Testing of Reactor Coolant System (Refueling Shutdown Interval).
5. GL 88-05, Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants.
6. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
7. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
8. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric
9. OST-051 Rev. 29, Reactor Coolant System Leakage Evaluation
10. OST-052
11. OST-053
12. PLP-040, Rev. 11, Boric Acid Corrosion Control Program.
13. Program Health Report (nonpublic), BACC Program Health (07-01-2012 – 09-30-2012), Dec. 3, 2012.
14. RNP-L/LR-0601 (nonpublic), Rev. 5, Aging Management Program Boric Acid Corrosion Program, June 2004.

B.4.6. Summary

The RNP AMP B.3.2 is an existing program that has been enhanced to manage the aging effects. It consists of (a) visual inspections of external surfaces potentially exposed to borated water leakage, (b) timely discovery of leak path and removal of boric acid residues, (c) assessment of the damage, and (d) follow-up inspections for adequacy of corrective actions. The program was implemented in response to NRC Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants." The aging effects/mechanisms of concern include (i) loss of material due to aggressive chemical attack and general, crevice, and pitting corrosion, and (ii) loss of mechanical closure integrity due to loss of material from aggressive chemical attack.

The program scope was originally limited to carbon steel SSCs that were exposed to leaking coolant from the reactor coolant pressure boundary. In addition, sources of borated water, other than from the reactor coolant system and components not part of the reactor coolant pressure boundary, were not specifically within the scope of the RNP original B.3.2 program. The program also did not address aluminum components. As a result of its license renewal review, the program scope was enhanced to (1) ensure that mechanical, structural, and electrical components which are within the scope for license renewal are covered, and (2) identify additional areas in which components may be susceptible to exposure from boric acid (e.g., containment, auxiliary, and spent fuel buildings). The structures and components that are included in this program and are also addressed in the GALL report are listed in Attachment 1 of RNP-L/LR-0601, Rev. 5. In addition, the RNP program includes components that are either not addressed in GALL or not listed as being susceptible to boric acid corrosion. These components are listed in attachment 2 of RNP-L/LR-0601, Rev. 5.

RNP noted that with the enhancements, the RNP AMP B.3.2 would be consistent with the AMP XI.M10 in GALL Rev. 0.

The original program (before license renewal) is described in RNP procedure documents PLP-040 Rev. 11, "Boric Acid Corrosion Control Program, Status" and OST-051 Rev. 29, "Reactor Coolant System Leakage Evaluation." The PLP-040 procedure has been superseded by EGR-NGGC-0207 Rev. 3, "Boric Acid Corrosion Control." The ten program elements of the RNP AMP B.3.2 are evaluated in calculation RNP-L/LR-0601.

B.5 Nickel-Alloy Nozzles and Penetrations (LRA Section B.4.1)

Associated GALL Report AMP: **2001 GALL Report, XI.M11 Nickel-Alloy Nozzles and Penetrations**

B.5.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.4.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The RNP AMP B.4.1 "Nickel-Alloy Nozzles and Penetrations Program" fulfills the license renewal Commitment #31 which commits RNP to incorporate the following: (1) Evaluations of indications performed under the ASME B&PV Code, Section XI program. (2) Corrective actions for augmented inspections performed in accordance with repair and replacement procedures equivalent to those requirements In ASME Code, Section XI. (3) Maintain involvement in industry initiatives, and evaluate implementation of applicable programmatic enhancements that are agreed upon between the NRC and industry to monitor, detect, evaluate, and correct cracking in the RPV penetration nozzles, specifically as the actions relate to ensuring the integrity of RPV penetration nozzles in the upper reactor vessel head during the period of extended operation. (4) Submit, for review and approval, its inspection plan for the AMP B.4.1, as it will be implemented from the applicant's participation in industry initiatives, prior to July 31, 2009. The RNP program is consistent with the GALL AMP. The AMP incorporates three enhancements listed in items 1- 3 above and affect program elements for Scope of Program,	Note that the GALL Rev. 2 AMP XI.M11B replaces AMPs XI.M11 "Nickel-Alloy Nozzles and Penetration" and XI.M11A "Nickel-Alloy Penetration Nozzles Welded to the Upper Reactor Vessel Closure Heads of Pressurized Water Reactors." It addresses the issue of cracking of Ni-alloy components as well as loss of material due to boric acid-induced corrosion in susceptible, safety-related components near Ni-alloy reactor coolant pressure boundary components. The RNP AMP is consistent with GALL AMP XI.M11. The augmented program described in GALL Rev. 2, includes Ni-alloy components of the pressurizer, reactor vessel lower head, Ni-alloy vessel head penetrations, as well as dissimilar metal welds of the RCPB. GALL AMP XI.M11B also indicates that a final rule (Sept. 2008) updating 10 CFR 50.55a, requires the augmented inspections in accordance with the following ASME Code Cases: (a) N-722, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials, Section XI, Division 1" and (b) N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1." In addition, GALL Rev. 2 states that reactor coolant

Program Element	Element of Licensee's AMP (LRA Section B.4.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Acceptance Criteria, and Corrective Actions.	pressure boundary cracking and leakage are monitored by the applicant's ISI program in accordance with 10 CFR 50.55a and industry guidelines (e.g., MRP-139). Furthermore, a final rule updating 10 CFR 50.55a, issued on June 11, 2011, addresses the augmentation of inservice inspections, per ASME CC N-770-1, CC N-722-1, and CC N-729-1, with the conditions specified in Part 50.55a.
1. Scope of Program	This program is focused on managing cracking due to PWSCC. The components that credit this AMP include CRD head penetration nozzles, head penetrations, top head vent pipe and instrumentation tube penetrations, and flux thimbles. These components are consistent with those listed in GALL, except flux thimbles, which are not addressed in the GALL report. RNP response to Bulletin 2001-01 is documented in RNP-RA/01-0133. RNP describes that, consistent with the GALL AMP, ISI is performed in accordance with ASME Subsection IWB, Table IWB 2500-1 RNP's position with regard to NRC GL 97-01 is contained in the correspondence between RNP and NRC (RNP-RA/97-0167 and RNP-RA/99-0024). However, subsequent to GL 97-01, Bulletin 2001-01 was issued, which addressed recent experiences that raised concerns regarding the structural integrity of RPV head penetration nozzles. Licensees were requested to provide information related to this issue, the inspections and repairs that have been undertaken, and the basis for concluding that their plans for future inspections will ensure compliance with applicable regulatory requirements. RNP's position with regard to this issue is documented in RNP-RA/01-0151, -0153, -0161, -0166, and -0170. *Enhancement*: RNP will continue to participate in industry initiatives (EPRI PWR Materials Reliability Program)	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	related to this issue.	
2. Preventive Actions	The RNP Water Chemistry Program is implemented to mitigate PWSCC. It is based on the EPRI water chemistry guidelines, and has exceptions that have been evaluated in RNP document RNP-L/LR-0600.	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): The susceptibility of Ni-alloys to PWSCC is strongly dependent on the water chemistry, particularly the electrochemical potential ECP of the environment and the impurity content (e.g., sulfate and chloride). Therefore, it would be prudent to obtain information as to how the monitoring and trending information from the RNP Water Chemistry Program is used, if at all, to the identification of the root cause of PWSCC in Ni-alloy components.
3. Parameters Monitored/ Inspected	The RNP AMP for ASME Section XI ISI includes augmented inspections of Ni-alloy nozzles and penetrations. Evaluations of indications and corrective actions are performed in accordance with ASME Section XI. Industry material initiatives are managed and addressed as provided in RNP document ADM-NGGC-0112, "Reactor Coolant System Material Integrity Management Program." In addition, as part of license renewal Commitment #31, RNP document RNP-RA/09-0067 submitted the Ni-alloy nozzles and penetration program inspection plan for NRC review and approval.	No significant issue or further review item was identified.
4. Detection of Aging Effects	PWSCC susceptibility assessment was performed in response to NRC GL 97-01 and resolution of Bulletin 2001-01. The information used to develop a plant-specific long-term inspection program and schedule. Industry material initiatives are managed and addressed as provided in RNP document ADM-NGGC-0112. The issue of leakage detection has been addressed during the process of resolution of Bulletin 2001-01 as documented in the correspondence between RNP and the	As discussed below in program element 9, the schedule for non-visual inspection of the upper vessel head penetrations, specified in the inspection plan submitted by RNP to NRC, had not been revised/updated when the original RPV upper head with Alloy 600 penetrations was replaced in 2005 with a head with Alloy 690 penetrations.

Program Element	Element of Licensee's AMP (LRA Section B.4.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	NRC (RNP-RA/01-0151, -0153, -0161, -0166, and -0170).	
5. Monitoring and Trending	PWSCC susceptibility assessment was performed in response to NRC GL 97-01 and resolution of Bulletin 2001-01. The information used to develop a plant-specific long-term inspection program and schedule. Program enhancements developed based on the resolution of Bulletin 2001-01 and participation in industry activities are folded into the existing RNP AMP.	The GALL Rev. 2 states, "Reactor coolant pressure boundary leakage is calculated and trended on a routine basis in accordance with technical specification to detect changes in the leakage rates. Flaw evaluation through 10 CFR 50.55a is a means to monitor cracking."
6. Acceptance Criteria	*Enhancement*: Evaluations of indications performed under the ASME B&PV Code, Section XI program (RNP-L/LR-0606). For the adequacy of the long-term inspection program, see evaluation of elements 1-3 and 1-5.	No significant issue or further review item was identified.
7. Corrective Actions		SRP-LR, Rev, 2, Appendix Section A.1.2.3.8, states that: The confirmation process should be described. The process ensures that preventive actions are adequate and that appropriate corrective actions have been completed and effective. The effectiveness of prevention and mitigation programs should be verified periodically. For example, in managing internal corrosion of piping, a mitigation program (water chemistry) may be used to minimize susceptibility to corrosion. However, it also may be necessary to have a condition monitoring program (ultrasonic inspection) to verify that corrosion is indeed insignificant.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		

Program Element	Element of Licensee's AMP (LRA Section B.4.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
10. Operating Experience	The GALL report is based on industry OE through April 2001. RNP has reviewed the applicability of recent industry OE (2001) and has committed to capture subsequent experience through the normal OE review process described in CAP-NGGC-0202, Rev. 3. RNP-L/LR-0620 further states that recent events, documented in NRC Bulletin 2001-01, have generated increased scrutiny of this issue beyond those recognized in NRC GL 97-01. Since this issue required resolution during the initial licensing period, RNP has committed to continue participating in industry initiatives (WOG and EPRI MRP) to ensure that the components managed are maintained within the current licensing basis (CLB) during the period of extended operation.	No significant issue or further review item was identified.

B.5.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.5.5. Documents Reviewed during the Audit

1. 10 CFR 50.55a.
2. ADM-NGGC-0112, Rev. 5, Reactor Coolant System Material Integrity Management Program.
3. ASME CC N-722-1, Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components
4. ASME CC N-729-1, Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1.
5. ASME CC N-770-1
6. ASME Section XI, Inservice Inspection (ISI), Subsections IWB, IWC, and IWD Program.
7. CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.

8. GL 97-01
9. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
10. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
11. Letter from John A. Grobe, U.S. NRC to James H. Riley, NEI, NRC Staff Position on Use of ASME Code Case N-729-1 in Lieu of First Revised NRC Order EA-03-009, Aug. 9, 2006
12. MRP-139
13. NRC Order EA-03-009
14. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
15. RNP-L/LR-0601 (nonpublic), Rev. 5, Aging Management Program Boric Acid Corrosion Program, June 2004.
16. RNP-RA/03-0031, Response to Request for Additional Information Regarding Application for Renewal of Operating License, 04/28/03.
17. RNP-RA/03-0133, Letter from C. T. Baucom, Progress Energy to U.S. NRC, Comments on Draft Safety Evaluation Report for License Renewal, Nov. 7, 2003.
18. RNP-RA/09-0067 (nonpublic), Letter from C. A. Castell, Progress Energy to U.S. NRC, Nickel-Alloy Nozzles and Penetrations Program Inspection Plan, July 29, 2009.
19. SRP-LR, Rev. 2, Appendix Section A.1.2.3.8

B.5.6. Summary

This is a new program credited for managing the aging effects of primary water stress corrosion cracking (PWSCC) in Nickel-alloy nozzles and penetrations. The program consists of (a) PWSCC susceptibility assessment to identify susceptible components, (b) monitoring and control of reactor coolant water chemistry to mitigate PWSCC, and (c) inservice inspection (ISI) of reactor vessel head penetrations to monitor PWSCC and its effect on the intended function of the component. For susceptible penetrations and locations, the program includes an industry wide, integrated, long-term inspection program based on the industry responses to NRC Generic Letter (GL) 97-01. In addition, prior to the period of extended operation, the RNP AMP B.4.1 program will incorporate the following:

(1) Perform evaluation of indications under the ASME Section XI program.

(2) Perform corrective actions for augmented inspections to repair and replacement procedures equivalent to those requirements in ASME Section XI.

(3) Maintain involvement in industry initiatives (such as the Westinghouse Owners Group and the EPRI Materials Reliability Project) during the period of extended operation.

In its SER, the staff concluded that the RNP program B.4.1 with the enhancements is consistent with the program attributes recommended by the GALL Rev. 0 AMP, XI.M11.

The reviewers noted that on Feb. 11, 2003, the staff issued NRC Order EA-03-009 to all holders of operating licenses for PWR-designated nuclear plants, which required all PWR licensees to perform augmented inspections of their facility's Alloy 600 penetration nozzles and welds connecting the nozzles to the upper RV heads. These augmented inspections include a combination of visual examinations and nonvisual NDE techniques that are required to be implemented at specific frequencies.

The RNP AMP B.4.1 was amended to reflect the requirements of the augmented inspection of EA-03-009. In CP&L Serial Letter RNP-RA/03-0031 Attachment II, the revision to Commitment #31 states that the new inspection plan for RNP's vessel head penetration nozzles and their partial penetration J-groove welds will be in compliance with the augmented inspection requirements in NRC Order EA-03-009. The inspection plan was subsequently submitted on July 29, 2009 (CP&L Serial Letter RNP-RA/09-0067). The plan lists all components that are inspected. However, NRC inspections performed under IP 71003 in Feb. 2010, identified a discrepancy. The inspection plan was based on the original Alloy 600 upper vessel head penetrations, whereas the ISI plan should have been for the new head that was installed in 2005, in which the vessel head penetrations were fabricated of Alloy 690.

During the audit, RNP was requested to (a) clarify whether such discrepancies have been corrected and (b) describe the methodology used to perform updates of the AMP and its implementation in response to (i) any change/addition of equipment, (ii) changes in OE, (iii) changes in the NRC or industry guidance, and (iv) changes related to power uprates. RNP stated that the applicability of recent industry OE (2001) has been reviewed and is committed to capture subsequent experience through the normal OE review process described in CAP-NGGC-0202, Rev. 3. Calculation RNP-L/LR-0620 further states that the events documented in NRC Bulletin 2001-01 have generated increased scrutiny of this issue beyond those recognized in NRC GL 97-01. Since this issue required resolution during the initial licensing period, RNP has committed to continue participation in industry initiatives (WOG and EPRI MRP) to ensure that the components managed are maintained within the CLB during the period of extended operation. The licensee added that modifications/updates as a result of OE or design change are part of the follow-up activity or corrective action. The licensee acknowledged that the inspection plan submitted to NRC had not been updated to reflect the change in the reactor vessel head.

The reviewers noted that the GALL Rev. 0 AMP XI.M11 has been replaced in GALL Rev. 2 by XI.M11B program, which addresses the issue of cracking of Ni-alloy components, as well as loss of material due to boric acid-induced corrosion, in susceptible, safety-related components near Ni-alloy reactor coolant pressure boundary components. However, although the GALL AMP X11B includes aging management of loss of material due to boric acid-induced corrosion, the program simply calls for the Boric Acid Corrosion program XI.M10 to manage such effects. The RNP program is consistent with GALL Rev. 0 AMP XI/M11, and does not include aging management of loss of material due to boric acid-induced corrosion.

The reviewers also noted that the GALL Rev. 2 program XI.M11B indicates that the final rule updating 10 CFR Part 50.55a on Sept. 2008 requires the augmented inspections in accordance with the following ASME Code Cases: (a) N-722, “Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated with Alloy 600/82/182 Materials, Section XI, Division 1” and (b) N-729-1,

“Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1.” In addition, the final rule issued on June 11, 2011 updating Part 50.55a addresses the augmentation of ISIs per ASME CC N-770-1, CC N-722-1, and CC N-729-1 with the conditions specified in Part 50.55a. CC N-770-1 describes the alternative examination requirements and acceptance standards for Class 1 PWR piping and vessel nozzle butt welds fabricated from Alloy 82 or 182 weld metal with or without application of listed mitigation activities. GALL AMP XI.M11B states that pending the incorporation of CC N-770, containing comprehensive inspection requirements for Ni-alloy butt welds, into 10 CFR 50.55a, the GALL program XI.M11B recommends that the reactor coolant pressure boundary cracking and leakage are monitored by the applicant’s ISI program in accordance with 10 CFR 50.55a and industry guidelines (e.g., MRP-139).

During the audit, RNP was requested to clarify how the licensee’s program has been revised to implement the aforementioned changes in 10 CFR Part 50.55a, NRC guidance, and industry events and programs. The licensee noted that the 4th 10-yr inspection interval was extended till July 2012. The 5th 10-yr interval started after that, and the three Code Cases, N-770-1, CC N-722-1, and CC N-729-1, were identified and are implement through the augmented inspection program. RNP stated that the inspection interval is typically adjusted to ensure that the last inspection and the end of the license term occur at the same time. RNP further added that all augmented inspections are performed under the RNP ASME Section XI, Subsection IWB, IWC, and IWD program and not as a separate program based on 10 CFR 50.55a requirements.

The reviewers noted that the susceptibility of Ni-alloys to PWSCC is strongly dependent on the water chemistry, particularly the electrochemical potential (ECP) of the environment and the impurity content (e.g., sulfate and chloride). Therefore, reviewers asked RNP whether information from the water chemistry monitoring AMP is analyzed to evaluate possible impact on the activities in this AMP, or if PWSCC is observed, does this AMP initiate such an evaluation. Unfortunately, the RNP engineer responsible for the Ni-alloy cracking program was not aware of such activity and suggested to check the RNP water chemistry AMP.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): The GALL Ni-alloy cracking program is the only GALL AMP that recommends that the inspection methods, schedules, and frequencies, as well as the acceptance criteria including flaw tolerance evaluations, repairs, and replacements are performed in accordance with 10 CFR 50.55a and industry guidelines (e.g., MRP-139). None of the other AMPs propose 10 CFR 50.55a requirements; instead they propose that ISI should be performed in accordance with relevant subsections of ASME Section XI and any additional specific guidance such as approved Code Case, NRC documents (NUREG, GL, or Bulletin), or industry guidelines. In fact, the description of this AMP in Rev. 1 of GALL seems to be better (specifies the additional specific guidance) than that in Rev. 2 (just states 10 CFR 50.55a requirements without giving any details).

B.6 Thermal Aging Embrittlement of CASS Program (LRA Section B.4.2)

Associated GALL Report AMP: **2001 GALL Report, XI.M12 Thermal Aging Embrittlement of Cast Austenitic Stainless Steels (CASS)**

B.6.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.4.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The RNP AMP B.4.2 "Thermal Aging Embrittlement of CASS Program" fulfills the license renewal Commitment #30 which commits RNP to implement the thermal aging embrittlement of CASS program, which is applied to CASS components within the Class 1 boundaries of the RCS and connected systems where operating temperature exceeds the threshold criterion. The AMP is credited for managing loss of fracture toughness due to thermal embrittlement of the CASS materials.	No significant issue or further review item was identified.
1. Scope of Program	The AMP covers CASS components within Class 1 boundaries of the RCS and connected systems where operating temperatures exceed the threshold criteria of 482°F, and includes CASS valves, pump casings, and piping elbows/fittings in the primary loop. RNP does not have any Nb-bearing CASS materials. No Class 2 or 3 CASS components exceed threshold temperature criteria. The balance of primary loop piping and branch piping is forged, and not susceptible to thermal aging. Program does not include RVIs, which is addressed in the PWR Vessel Internals Program B.4.3.	RNP-L/LR-0621 states that all CASS components within Class 1 boundaries are initially considered susceptible to the thermal aging embrittlement aging mechanism irrespective of material. For primary loop piping, LBB analyses consider material property assuming thermally aged conditions over the period of license renewal (WCAP-15628). Valves and pump casings are adequately covered by existing inspection requirements in Section XI of the ASME Code, including the alternative requirements of N-481. CC N-481 applicability analyses are also performed using thermally aged material properties (WCAP-15363). RNP is committed to perform these flaw tolerance analyses using thermally aged material properties.
2. Preventive Actions	The AMP consists of evaluation and inspection and provides no guidance on methods to mitigate thermal	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	aging embrittlement.	
3. Parameters Monitored/ Inspected	Program addresses loss of fracture toughness on the intended function of the component consistent with Grimes letter on thermal embrittlement. RNP-RA/01-0100 covers ISI program for the 4th 10-year interval and PLP-025 Rev 15 covers the RNP ISI program. The PLP-025 Rev 15 program includes ISI, IST, App. J leak testing, repair and replacement, system pressure testing, and IWE/IWL containment inspection programs. It supports the following AMPs: XI.M12, XI.M16A, XI.M11, and XI.M3, among others. For potentially susceptible materials, the program relies on examination and plant/component specific flaw tolerance evaluation. WCAP-15628 provides justification for eliminating large primary loop pipe rupture and WCAP-15363 demonstrates the applicability of N-481.	No significant issue or further review item was identified.
4. Detection of Aging Effects	Consistent with NRC guidance, the RNP Program does not include additional inspections of pump casings, valve bodies, or piping (RNP-RA/01-0100). A Westinghouse evaluation has been performed demonstrating applicability of Code Case N-481 (which incorporates surface exams) to RNP RCP casings over the period of extended operation (WCAP-15363). Calculation RNP-L/LR-0505, addresses applicability of the Westinghouse RCP casing TLAA review to RNP, and RNP-L/LR-0504 addresses the applicability of Westinghouse LBB flaw evaluation to RNP.	RNP states that the LBB evaluation demonstrates large margin between detectable flaw size and flaw instability. Therefore, an AMP to manage thermal embrittlement effects on primary loop piping/fittings is not required.
5. Monitoring and Trending	Inspection of valves, piping/fittings and pump casings performed under the Section XI Program in accordance with IWB-2400 or IWC-2400; reliable examination methods provide timely detection of cracks (RNP-RA/01-	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	0100).	
6. Acceptance Criteria	Flaws detected in CASS components are evaluated in accordance with the applicable procedures of IWB-3500 or IWC-3500 (RNP-RA/01-0100). In addition, RNP-L/LR-0621 states that flaw tolerance evaluations for RCP casings and primary loop CASS components are done based on fracture toughness methodology approved by the NRC for this purpose. The GALL report states that flaw tolerance evaluation for components with ferrite content up to 25% is performed according to the principles associated with IWB-3640 procedures for submerged arc welds (SAW), disregarding the Code restriction of 20% ferrite in IWB-3641(b)(1).	
7. Corrective Actions	Under Section XI Program, repair is in conformance with IWA-4000 and IWB-4000 or IWC, and replacement is in accordance with IWA-7000 and IWB-7000 or IWC-7000.	No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The GALL report is based on industry OE through April 2001. Recent industry operating experience (2001) has been reviewed by RNP for applicability. Subsequent operating experience will be captured through the normal OE review process (CAP-NGGC-0202, Rev 3). The ISI Program and procedures are generally credited with implementation of the Thermal Aging Embrittlement Program. This program is described in Calculation RNP-L/LR-0606, and discussion of program effectiveness	

Program Element	Element of Licensee's AMP (LRA Section B.4.2)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	based on operating experience is provided in that calculation (RNP-L/LR-0606).	

B.6.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.6.5. Documents Reviewed during the Audit

1. CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.
2. CC N-481
3. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
4. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
5. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
6. PLP-025, Rev. 15, Inservice Inspection Programs, June 2004.
7. RNP-RA/01-0100
8. RNP-L/LR-0504
9. RNP-L/LR-0505
10. RNP-L/LR-0606
11. RNP-L/LR-0621, Rev. 2, Aging Management Program Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS) Program, June 2004.
12. WCAP-15363
13. WCAP-15628

B.6.6. Summary

The RNP AMP B.4.2 is a new program that is credited for aging management of CASS components within Class 1 boundaries of the reactor coolant system (RCS) and connected systems where operating temperature exceeds the threshold criterion [i.e., above 250°C (482°F)]. The program manages the effects of loss of fracture toughness due to thermal embrittlement of CASS components. The AMP covers CASS components within Class 1 boundaries of the RCS and connected systems, and includes CASS valves, RCP casings, and piping elbows/fittings in the primary loop. The RNP primary loop piping and branch piping is forged stainless steel and therefore not susceptible to thermal aging embrittlement. The RNP LRA noted that no Class 2 or 3 CASS components exceed the threshold temperature criterion. The program does not cover CASS components in the reactor vessel internals and core support structures; aging effects of reactor vessel internals CASS components are managed by the RNP PWR Vessel Internals program B.4.3. The ten program elements of the RNP AMP B.4.2 are evaluated in calculation RNP-L/LR-0621.

The program addresses loss of fracture toughness on the intended function of the component, consistent with Grimes letter on thermal embrittlement. For potentially susceptible materials, the program relies on examination and plant/component specific flaw tolerance evaluation. Calculation RNP-RA/01-0100 describes the ISI plan for the 4th 10-year interval, and PLP-025 Rev 15 describes the RNP ISI program procedures. The PLP-025 R15 program includes ISI, IST, Appendix J leak testing, repair and replacement, system pressure testing, and IWE/IWL containment inspection programs. Calculation RNP-L/LR-0621 states that all CASS components within Class 1 boundaries are initially considered susceptible to the thermal aging embrittlement aging mechanism, irrespective of material. Calculation RNP-L/LR-0621 noted that RNP does not have any Nb-bearing CASS materials.

Calculation RNP-L/LR-0621 states that valves and pump casings are adequately covered by existing inspection requirements in Section XI of the ASME Code, including the alternative requirements of Code Case (CC) N-481. Consistent with NRC guidance, the RNP AMP B.4.2 does not include additional inspections of pump casings, valve bodies, or piping (RNP-RA/01-0100). Westinghouse report WCAP-15363 presents an evaluation that demonstrates the applicability of CC N-481, which incorporates surface exams, to RNP RCP casings over the period of extended operation; the analysis used thermally aged material properties. Calculation RNP-L/ LR-0505 addresses applicability of the Westinghouse RCP casing TLAA review to RNP.

For primary loop piping, Westinghouse report WCAP-15628 describes a leak-before-break (LBB) flaw evaluation that justifies eliminating large primary loop pipe rupture. The LBB analyses also consider material property assuming thermally aged conditions over the period of license renewal. The results indicate large margin between detectable flaw size and flaw instability. Calculation RNP-L/LR-0504 addresses the applicability of the Westinghouse LBB flaw evaluation to RNP. Therefore, an AMP to manage thermal embrittlement effects on primary loop piping/fittings is not required.

However, the reviewers noted that RNP did not clarify whether any of the RNP CASS materials used in the primary loop piping elbows and fittings contained greater than 25% ferrite. The guidance in the GALL AMP regarding the bounding minimum fracture toughness of thermally aged CASS material, being similar to that for flux welds with up to 20% ferrite, is not applicable for CASS materials containing greater than 25% ferrite. Flaw tolerance evaluation, for CASS materials with greater than 25% ferrite, is performed on a case-by-case

basis, by using the applicant's fracture toughness data.

The reviewers also noted that both CC N-481 applicability and LBB analyses were performed using thermally aged material properties. However, it is not clear whether the thermally aged CASS material or thermally aged weld, which also has a duplex structure, was considered to provide the bounding analysis. Since the fracture toughness of unaged flux weld is considered to be the bounding fracture toughness of thermally aged CASS materials, thermally aged weld properties would provide the bounding LBB or CC N-481 applicability analyses. RNP was requested to clarify whether the analyses in WCAP-15363 and WCAP-15628 were performed using mechanical properties for thermally aged CASS material or thermally aged weld. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): specifically mention welds in this AMP.

B.7 PWR Vessel Internals (LRA Section B.4.3)

Associated GALL Report AMP: **2001 GALL Report, XI.M16A PWR Vessel Internals**

B.7.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The RNP AMP B.4.3 "PWR Vessel Internals" program is a new program based on the guidance provided in MRP-227 and MRP-228, and is described in detail in WCAP-17077-NP Rev. 1, and also in RNP document RNP-L/LR-0614. It utilizes a combination of prevention, mitigation, and condition monitoring activities. Where applicable, credit is taken for existing programs such as water chemistry, inspections in accordance with ASME Section XI ISI, thimble tube inspections, and mitigation activities such as split pin replacement, and combination of augmented inspections and evaluations as recommended in MRP-227-A. The RVIs AMP fulfills the license renewal Commitment #33, which commits RNP to: *Participate in industry programs to investigate aging effects and determine the appropriate AMP activities to address baffle and former assembly issues, and to address changes in dimensions due to void swelling.* *Evaluate the results of completed research projects from the Westinghouse Owners Group (formerly WOG, now PWROG) and the EPRI MRP, and factor them into the PWR Vessel Internals Program as appropriate.* *Implement an augmented inspection during the license renewal term.* In addition, as part of fulfilling Commitment #33, the	At the time when RNP AMP B.4.3 was developed and described in WCAP-17077-NP, the details regarding the augmented inspections, and the associated corrective actions for these inspections, had not been established. WCAP-17077-NP states that the EVT-1 specification augments the VT-1 requirements, to provide more rigorous inspection standards for SCC as demonstrated for similar inspections in BWR internals. EVT-1 is also conducted in accordance with the requirements described for visual VT-1 examination with additional requirements (such as camera scanning speed) currently being developed by the industry. The program described in RNP-L/LR-0614 states that the RNP AMP recommends more stringent inspection such as enhanced VT-1 examination or UT. Enhanced visual VT-1 examination should include the ability to achieve a 0.5-mil resolution with the conditions (e.g. lighting and surface conditions) of the inservice examination bounded by those used to demonstrate the technique. Note that WCAP-17077 Rev. 1 with the AMP description was published in 2011 and the RNP-L/LR-0614 document with the existing program description was last revised in 2004. **ACTION ITEM** for Consideration for writing SLR-GDs (as result of audit): Verify AMP XI.M16A is consistent with the

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	program description in WCAP-17077-NP states that augmented inspections, based on required program enhancements resulting from industry programs, will become part of the ASME B&PV Code, Section XI program at RNP. Furthermore, corrective actions for augmented inspections will be developed using repair and replacement procedures equivalent to those requirements in ASME B&PV Code, Section XI, or as determined independently by Progress Energy, or in cooperation with the industry, to be equivalent or more rigorous than currently defined procedures. In accordance with license renewal Commitment #33, RNP submitted WCAP-17007-NP with the inspection plan for RVIs, 24 months prior to the augmented inspections. However, in the interim, NRC published RIS 2011-07 "License Renewal Submittal Information for Pressurized Water Reactor Internals Aging Management," which implemented new guidelines as to when plants must submit an inspection plan. It allowed licenses to withdraw their submittal and resubmit a new and updated AMP no later than October 1, 2012. The AMP described in WCAP-17077-NP Rev. 1, incorporates the changes from MRP-227-A and RIS 2011-07. In addition, staff's evaluation of the RNP AMP B.4.3, as documented in NRC LRA SER, indicated that the consistency of the RNP AMP with GALL AMP XI.M16 could not be determined at the time of the LRA audit. For example, the applicant did not indicate whether the PWR Vessel Internals Program, as it currently exists, <u>will monitor for the following aging effects</u> in the RNP RV internal components: (1) Loss of material due to wear or erosion, (2) cracking due to thermal fatigue, SCC or IASCC, (3) loss of preload due to stress relaxation in RV internal bolted or fastened connections, (4) loss of fracture	latest staff expectations, i.e. RIS 2011-07 and MRP-227

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	toughness due to neutron irradiation embrittlement or to thermal aging for CASS, martensitic SS, or precipitation hardened SSs and (5) dimensional changes due to void swelling. A review of the AMP described in WCAP-17077-NP indicates that the RNP AMP B.4.3 is credited for the aging management of RVI components for the all of these aging degradation mechanisms and their associated effects.	
1. Scope of Program	The RNP RVI consists of two basic assemblies: (1) An upper internals assembly that is removed during each refueling operation to obtain access to the reactor core, and (2) a lower internals assembly that can be removed, if desired, following a full core offload. The WCAP-17077-NP Rev. 1 states that <u>the scope of the RNP RVI program is based on previously established and approved GALL Report approaches through application of the WCAP-14577 methodologies</u> to identify those components that require aging management. These components/commodity groups and their intended function are listed in Table 2.3-1 of the Robinson LRA. The details of the Robinson RVI AMR process are documented in RNP documents RNP-L/LR-0354A, Rev. 3 and RNP-L/LR-0354B, Rev. 2 for reactor vessel and RVIs, respectively. The results are tabulated in Appendix B of the Westinghouse report WCAP-17077-NP. The tables list the aging effects during the period of extended operation and the AMP activities that are credited to address these effects.	No significant issue or further review item was identified.
2. Preventive Actions	The RNP RVI AMP <u>relies on PWR water chemistry control to prevent or mitigate aging effects</u> that can be induced by corrosion mechanisms such as general, pitting, or crevice corrosion, or any form of SCC (IGSCC, PWSCC or IASCC).	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	In addition, in response to industry's concern for SCC, the control rod guide tube slit pins, which were fabricated from Inconel X-750, were replaced during 1990 RO-13 and 2010 RO-26 with a Westinghouse-designed cold-worked Type 316 SS support pins. The pins made from X-750 material and the associated heat treatment was shown to be susceptible to IGSCC and likely to fail during the lifetime of the NPP. Furthermore, to address the problems associated with degradation of Alloy 600 material due to PWSCC, RNP replaced the original reactor vessel head with a head that used more resistant material (e.g., Alloy 690). A side effect to this replacement was the introduction of design features to facilitate refueling outage activities.	
3. Parameters Monitored/ Inspected	The RNP AMP monitors, inspects, and/or tests for the effects of the following aging degradation effects and the associated mechanisms, on the intended function of the RNP PWR internals components, through inspection and condition monitoring activities in accordance with the augmented requirements defined under industry directives, as contained in MRP-227-A and ASME Section XI: (a) Cracking due to SCC, IASCC, and fatigue; (b) Loss of material due to wear; (c) Reduced fracture toughness due to thermal aging embrittlement and irradiation embrittlement; (d) Dimensional change and distortion and possible cracking due to void swelling and irradiation growth, and (e) Loss of preload due to thermal and irradiation-enhanced stress relaxation (or irradiation-enhanced creep), which may eventually cause subsequent degradation, by fatigue and wear, and result in cracking.	Since the RNP AMP relies entirely on the recommendations of industry initiatives as the basis for developing the inspection plan for RVIs, which may not be consistent with the staff's approach taken in certain AMRs in the GALL report, particularly RVIs that may be susceptible to void swelling or irradiation embrittlement (baffle bolts), *how has RNP modified or updated the AMRs for RVIs?* (This concern is listed in RNP LRA SER bottom paragraph on page 3-117.)

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	The AMP implements the requirements for inspections of the Primary, Extension, and Existing Components listed in Tables 4-3, 4-6, and 4-9 of MRP-227-A. The categorization of the RVI components is as follows: Primary - highly susceptible, Extension - highly or moderately susceptible, and Existing - susceptible to at least one aging mechanism.	
4. Detection of Aging Effects	(From WCAP-17077-NP) Detection of indications required by the ASME Code Section XI is through the application of the well-established Section XI ISI program, and those for the MRP-227-S augmented inspections using MRP-228 inspection standards. Inspection can be used to detect physical effects of degradation including cracking, fracture, wear, and distortion. The recommendations are built around three basic inspection techniques: (1) visual, (2) ultrasonic, and (3) physical measurements. Three visual techniques are used VT-1, EVT-1, and VT-3. In the augmented inspections in MRP-227-A for RVIs, EVT-1 enhanced visual examination is identified for components where surface breaking flaws are a potential concern. For the MRP-227-A augmented inspections of RVIs, the VT-3 visual examination has been identified for components where general condition monitoring is required. UT techniques are used to identify and determine the length and depth of a crack in a component; UT inspections are recommended exclusively for detection of flaws in bolts Continued functionality is confirmed by physical measurements to evaluate the effects of various degradation mechanisms, such as wear or loss of functionality due to loss of preload or material deformation.	WCAP-17077-NP states that any recommendation for EVT-1 inspection will require additional analysis to establish flaw-tolerance criteria, which must take into account potential embrittlement due to thermal aging or neutron irradiation. The industry, through the PWROG, has developed an approach in WCAP-17077-NP, which states that industry has developed an approach for acceptance criteria methodologies to support plant-specific augmented examinations. This work is summarized in WCAP- 17096-NP, "Reactor Internals Acceptance Criteria Methodology and Data Requirements."

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
5. Monitoring and Trending	WCAP-17077-NP states: "Operating experience with PWR reactor internals has been generally proactive. The majority of the materials aging degradation models used to develop the MRP-227-A guidelines are based on test data from reactor internals components removed from service. The data is used to identify trends in materials degradation and forecast potential component degradation. The industry continues to share both material test data and operating experience through the auspices of the MRP and PWROG. Progress Energy has in the past and will continue to maintain cognizance of industry activities and shared information related to PWR internals inspection and aging management."	No significant issue or further review item was identified.
6. Acceptance Criteria	Recordable indications that result from inspections, required by the existing RNP ISI program scope, are evaluated in accordance with the applicable requirements of the ASME Code through the existing Corrective Action Program (NGG Standard Procedure CAP-NGGC-0200, Rev. 34). Inspection acceptance and expansion criteria are provided in Appendix C, Table C-4 of WCAP-17077-NP. Augmented inspections, as defined by the MRP-227-A requirements, are entered into the plant Corrective Action Program and addressed by appropriate actions that may include enhanced inspection, repair and replacement, mitigation actions, or analytical evaluations.	No significant issue or further review item was identified.
7. Corrective Actions	The existing RNP procedure for corrective actions are described in the "Condition Evaluation and Corrective Action Process," (NGG Standard Procedure CAP-NGGC-0205, Rev. 15) and for the ASME Section XI ISI program (RNP-L/LR-0606, Rev. 5). These requirements include the identification of a repair cycle, repair plan, and verification of acceptability for replacements.	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	Extensive industry and RNP OE has been reviewed during the development of the RVIs AMP. Most of the industry OE reviewed has involved cracking of austenitic stainless steel baffle-former bolts or SCC of high-strength internals bolting. SCC of control rod guide tube split pins has also been reported. Industry OE is routinely reviewed by RNP engineers using INPO OE, the Nuclear Network, and other information sources as directed under the applicable procedure, for the determination of additional actions and lessons learned. These insights are incorporated into the plant systems quarterly health reports and further evaluated for incorporation into plant programs. RNP has responded proactively to industry issues relative to RVIs degradation. Two examples that demonstrate this proactive response are (a) the replacement of CR guide tube split pins in 1990 and 2010, and (b) participation by RNP in the augmented examinations performed by the PWROG on control rod guide tube guide cards in spring 2010. Control rod guide tube guide card wear measurements, on a sample of guide tubes from selected representative pilot plants, were conducted to approximate the remaining life of the guide tube guide cards.	No significant issue or further review item was identified.

B.7.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.7.5. Documents Reviewed during the Audit

1. CAP-NGGC-0200, Rev. 34, NGG Standard Procedure.
2. CAP-NGGC-0205, Rev. 15, NGG Standard Procedure.
3. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
4. MRP-227-A
5. MRP-228
6. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
7. RIS 2011-07, License Renewal Submittal Information for Pressurized Water Reactor Internals Aging Management
8. RNP-L/LR-0354A, Rev. 3
9. RNP-L/LR-0354B, Rev. 2
10. RNP-L/LR-0614, Rev. 2, Aging Management Program, PWR Vessel Internals Program, May 2004.
11. WCAP-17096-NP, Reactor Internals Acceptance Criteria Methodology and Data Requirements.
12. WCAP-14577
13. WCAP-17077-NP, Rev. 0, PWR Vessel Internals Program Plan for Aging Management of Reactor Internals at Robinson Nuclear Plant, July 2009.
14. WCAP-17077-NP, Rev. 1, PWR Vessel Internals Program Plan for Aging Management of Reactor Internals at Robinson Nuclear Plant, July 2009.

B.7.6. Summary

This is a new program that is credited for managing the following aging degradation effects and the associated mechanisms on the intended function of the reactor internal components through inspection and condition monitoring activities in accordance with the

augmented requirements defined under industry directives as contained in MRP-227-A and ASME Section XI: (a) Cracking due to SCC, IASCC, and fatigue; (b) loss of material due to wear; (c) reduced fracture toughness due to thermal aging embrittlement and irradiation embrittlement; (d) dimensional change and distortion and possible cracking due to void swelling, and (e) loss of preload due to thermal and irradiation-enhanced stress relaxation (or irradiation-enhanced creep), which may eventually cause subsequent degradation by fatigue and wear, and result in cracking. Where applicable, credit is taken for existing programs such as water chemistry, inspections in accordance with ASME Section XI ISI, thimble tube inspections, and mitigation activities.

The RNP RVIs program fulfills the license renewal Commitment #33, which commits RNP to:

(d) *Participate in industry programs to investigate aging effects and determine the appropriate AMP activities to address baffle and former assembly issues, and to address changes in dimensions due to void swelling.*
(e) *Evaluate the results of completed research projects from the Westinghouse Owners Group (formerly WOG, now PWROG) and the EPRI MRP, and factor them into the PWR Vessel Internals Program as appropriate.*
(f) *Implement an augmented inspection during the license renewal term.*

In accordance with license renewal Commitment #33, RNP submitted WCAP-17077-NP with the inspection plan for RVIs, 24 months prior to the augmented inspections. However, in the interim, NRC published RIS 2011-07 “License Renewal Submittal Information for Pressurized Water Reactor Internals Aging Management,” which implemented new guidelines as to when plants must submit an inspection plan. It allowed licensees to withdraw their submittal and resubmit a new and updated AMP no later than October 1, 2012. The AMP described in WCAP-17077-NP Rev. 1, incorporates the changes from MRP-227-A and RIS 2011-07. The proposed PWR Vessel Internals AMP is currently being reviewed by the NRC staff.

During the audit, RNP described which RV internal components had been inspected under the augmented inspection plan. As part of the industry’s effort, RNP inspected the guide tubes and the results were published in a WCAP report. Since the last inspection was under the last 10-year inspection plan, it was performed in accordance with WCAP-17077-NP Rev. 0, which required EVT-1 of welds and VT-3 of bolts. The results indicated acceptable wear (i.e., in single digits). However, RNP plans to re-inspect the guide tubes during the next outage, RO-28. Visual inspection of former and baffle bolts and thermal shield flexures, etc. was also performed; no significant indications were reported. RNP also stated that volumetric examination of baffle bolts was not performed during the last outage; it is planned during RO-28 in the fall of 2013. Westinghouse is scheduled to perform the UT inspections using the procedures based on the operating experience at Ginna; Westinghouse has used these procedures before in Dutch nuclear power plants. RNP also noted that the hold-down spring is scheduled for replacement in RO-29, with a hold-down spring constructed of a material that is not susceptible to degradation.

B.8 Flow-Accelerated Corrosion Program (LRA Section B.3.3)

Associated GALL Report AMP: **2001 GALL Report, XI.M17 Flow-Accelerated Corrosion**

B.8.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected. If there is an issue, include pertinent text from the program description.	No significant issue or further review item was identified.
1. Scope of Program	The RNP LRA and SER note that the FAC AMP is consistent with the associated GALL report AMP XI.M37, with several enhancements. [From NRC IR 2010008] The RNP FAC AMP will be enhanced (a) to inspect for erosion wear in locations deemed susceptible by the system engineer, and (b) to add a section dedicated specifically to valves. Commitment #14 specified that prior to the PEO, the FAC AMP will be modified to include additional components potentially susceptible to flow-accelerated corrosion and/or erosion.	The stated enhancements to its FAC program included (1) addition of components in the site program documents for the scope, (2) inspecting for erosion wear in locations deemed to be susceptible, and (3) program revision prior to the PEO adding a section to its FAC program concerning valves. [From NRC IR 2003009] The AMP Implementing Documents database maintained by the license renewal personnel indicated that (a) there were five pending changes or enhancements to the program procedure, and (b) the FAC engineer was determining if measurement of pipe wall thickness just downstream of a given valve, instead of measuring valve bodies, may be more meaningful. At the time of its post-approval site inspection [NRC IR 2010008], this commitment item was partially completed, and additional tasks were pending to be implemented prior to the PEO.
2. Preventive Actions		Although the FAC program is not preventive, one of its objectives is to prevent failure of a component because of wall thinning. Relating to the PEO, according to the "Long-term Strategy" [NSAC-202L-R2 or R3 Guidelines] the FAC program should focus on reducing FAC wear rates, without

Program Element	Element of Licensee's AMP (LRA Section B.3.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		which the number of needed inspections will increase with service time, and even with selective repair and replacement, the likelihood of a consequential leak or rupture may increase with service time.
3. Parameters Monitored/ Inspected		No significant issue or further review item was identified.
4. Detection of Aging Effects		No significant issue or further review item was identified.
5. Monitoring and Trending		The RNP initial FAC program included components of steel alloys containing higher chromium (> 1%) content, until verification of their expected (low) FAC wall-thinning rates. Since the trending for erosion wear can be significantly different than that for FAC wear, one issue is consider what changes are implemented in the RNP AMP to augment FAC-based trending.
6. Acceptance Criteria		No significant issue or further review item was identified.
7. Corrective Actions	The LRA Section A.3.1.11 stated that prior to the PEO, the FAC AMP will be modified to specify corrective actions be taken in accordance with the CAP, when certain acceptance criteria are not met. Commitment #14 specified that prior to the PEO, the FAC AMP will be modified, to clarify when condition reports shall be initiated. [From NRC IR 2010008] The licensee stated that for corrective actions, its FAC AMP procedure will be revised to state that a condition report "shall" be initiated in accordance with the CAP for through-wall failures, or when actual wall thickness is found to be substantially less than the expected value.	Important considerations are the following: • What are these acceptance criteria mentioned in A.3.1.11, and are these different than AMP element #6? • Has this part of the LR Commitment #14 been satisfied? • (For the corrective actions) What is considered as "substantially less than the expected value" of actual thickness? Have there been any resultant instances of CRs?

Program Element	Element of Licensee's AMP (LRA Section B.3.3)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience		Subsequent to the program implementation (post-approval of LRA), has the iron transport measurement continued to show decreasing trend? The SER noted OE examples given by RNP for the piping replacements due to FAC, which were nearly 100 percent piping portions (complete replacements).

B.8.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

B.8.5. Documents Reviewed during the Audit

1. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
2. EPRI 1011838, NSAC-202L-R3, Recommendations for an Effective Flow Accelerated Corrosion Program, May 2006.
3. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
4. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
5. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
6. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004

B.8.6. Summary

Robinson LRA Section B.3.3 summarizes RNP's implementation of the associated GALL AMP XI.M17 – Flow-Accelerate Corrosion (Rev. 0 of GALL Report, 2001). The RNP AMP B.3.3 states that it is consistent, with several enhancements, with the associated GALL AMP XI.M17. Staff's SER (NUREG-1785) confirmed the consistency of RNP's AMP B.3.3 with the associated GALL AMP XI.M17 with enhancements, and staff's Post-approval Site Inspection for License Renewal Inspection Report (IR 201008) concluded that RNP actions and schedule had reasonable assurance to meet related commitments prior to the start of the PEO. The stated enhancements to its FAC AMP included: Addition of components in the site program documents for the scope, inspecting for erosion wear in locations deemed susceptible, and program revision prior to PEO adding a section to its program concerning valves.

The FAC AMP B.3.3 is credited for aging management of selected carbon steel and low-alloy steel piping and components in the following systems at RNP: Feedwater, Steam Generator Blowdown, Steam Generators, Auxiliary Feedwater, Condensate, and Main Steam, and additional non-safety related SSCs including Extraction Steam System and Auxiliary Boiler/Steam System, for managing the aging effects/mechanisms of loss of material due to FAC and loss of material due to erosion (in the FAC program systems and components).

The staff reviewed the status of RNP's FAC program implementation of the GALL AMP XI.M17 and asked about the basis document revision used in the FAC program, noting that the RNP UFSAR points to Rev. 2 of industry guidance (CHECWORKS program) while the current guidance is at Rev. 3. RNP stated that its implementation was updated with reference to the latest GALL Report that notes Rev. 2; however, RNP also did a "gap analysis" between Rev. 3 and Rev. 2 (of CHECWORKS), essentially concluding no significant impact for its AMP.

The staff asked for clarification if (and how) the RNP implementation in its CHECWORKS analysis included the use of a safety factor on calculated wear rate for projected wall thinning; RNP noted that this would be automatically done through its FAC Manager program. Also, the staff enquired about what actions are, or were undertaken when the specified threshold for wall thinning is reached; RNP indicated that the actions, such as generating a CR, are part of the built-in process followed under the FAC AMP implementation and that the current RNP database does not show this because there were no such instances in its history. However, the staff noted its observations pertaining to some FAC of heater drain locations at RNP, for which RNP thought a CR would have been relevant <u>and that it would provide more information to the staff on these observations</u>.

As a result of its implementation of LR Commitment and enhancements for the FAC AMP the following changes were noted by RNP to its AMP:

- The following components not specifically identified in the pre-approval site program were added to site program documents for FAC monitoring, as part of the System Elimination Analysis, with reference to LR commitment: Steam Nozzles, Feedwater Nozzles, SG Nozzle, Thermal Sleeves, and Temperature elements (Thermowells).

- The FAC Monitoring program revisions include:
  - Inspecting for erosion wear in locations identified by the system engineer.
  - Adding a section dedicated specifically to valves, and, as stated in the procedure, wear in the pipe downstream of valves is used as a leading indicator of valve wear unless the pipe is FAC-resistant.
  - Requiring alloy analysis for valves within the scope of License Renewal. The analysis has been completed on a number of valves.
  - Requiring initiation of a condition report, in accordance with its CAP under conditions stated in the program procedure.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): The staff noted and discussed with RNP the inclusion of wall loss due to erosion being also managed by RNP under its FAC AMP. RNP indicated that there was no apparent event or findings to prompt the inclusion of erosion, but plant specific observations suggested that any indication of erosion while inspecting FAC locations should be evaluated by engineering. RNP noted that the identification of erosion was mostly based on visual assessment of damage characteristics, and agreed that the rate of such damage would typically be not linear in time, and that the evaluation was done with case-by-case engineering judgment. RNP also opined that as a precautionary and/or confirmatory measure, it may be necessary to monitor for such erosion possibility following a design modification in the flow-path. RNP also indicated that the mention of some high-chromium components in its LRA FAC AMP was for a few locations as confirmatory for (absence of) FAC. These RNP observations and/or actions are prudent and relevant considerations for incorporating into GALL Report revision concerning non-FAC related wall thinning effects for the subsequent license renewal.

In one of its condition reports related to FAC, it was noted that three of its low-pressure feedwater heater shell walls were not inspected as expected, for thinning caused by *erosion*; the report was apparently in response to the INPO "Evaluator How-To *Flow Accelerated Corrosion*" guide concerning the timing of baseline wall thickness measurements for the nozzles and heater shells. As noted by RNP during the audit, the inspection for erosion is based on visual examination and a judgment using the appearance of damage, if any is identified.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): Taken together, these observations suggest that there is a general confusion about the terminology, if not the requirements, to inspect for and manage the wall thinning due to FAC, versus that due to erosion. The fact that there is no specific aging management program or guidance for wall thinning effects due to non-FAC mechanisms appears to be a contributing factor to this state.

The RNP implementation of this AMP notes the following cautions, which the staff finds to be good practices that would be effective additions to the Monitoring and Trending element of the GALL Report AMP:

(a) The presence of chromium content (trace Cr ≥ 0.10%) should be a consideration with respect to inspection coverage within components and lines (for line correction factors) selected for grouped analysis of wear and for susceptible but not-modeled components. Inspected components determined or known to contain ≥ 0.10% Cr may not accurately reflect the wear of similar non-inspected components with lower trace Cr. The material alloy section for analysis of components with measured wear data should be treated with careful consideration of this fact.

(b) **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Carbon steel pipe and components should not be eliminated from FAC Program consideration or monitoring based solely on alloy analysis of the pipe sections. Inspection results should corroborate the fact that no wear is occurring in order to form the basis for reduced FAC susceptibility. If replacing whole line segments with carbon steel material containing high trace Cr (>0.10%), or high trace Cr already exists, follow up inspections are warranted to validate that there is no wear taking place, prior to making any judgments of exclusion from the program, which must be documented in the susceptibility analysis.

(c) The program document should identify/list locations potentially susceptible to the “leading edge/entrance effect,” where FAC resistant material is located immediately upstream of a carbon steel component in an FAC susceptible system, and the list should be maintained as replacements are made in the plant that introduce new/additional locations.

(d) **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): For components repaired by means of external weld overlay, consideration should be given to the possibility for non-linear (higher) wear occurring within the degraded area, as the damaged surface itself becomes a source of contributory turbulence and flow irregularities.

B.9 Bolting Integrity Program (LRA Section B.3.4)

Associated GALL Report AMP: **2001 GALL Report, XI.M18 Bolting Integrity**

B.9.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected. If there is an issue, include pertinent text from the program description.	No significant issue or further review item was identified.
1. Scope of Program	The LRA and SER note that the RNP AMP B.3.4 is consistent with the associated GALL Report AMP XI.M18, with exceptions to the scope of program and inspection needs and requirements for monitoring cracking in high strength bolting of NSSS supports. The AMP B.3.4 has enhancements to its Preventive Actions element and its Parameters Monitored/Inspected element. The RNP Bolting Integrity AMP itself relies on other RNP AMPs.	NRC IR 2003009 and LRA section A.3.1.12 noted that (a) an enhancement to this AMP would include bolting requirements and inspections for the RCP cover to casing bolts in its Preventive Maintenance AMP, and (b) the use of molybdenum sulfide would be added to the site's bolting procedure. The exception to scope of program excludes AMR items for structural bolting to be managed under this AMP. This is consistent with the Rev.2 of GALL Report, provided the AMR items are crediting other relevant AMPs for these bolting.
2. Preventive Actions	The enhancement to Preventive Actions element stated that program documents will include prohibition on the use of molybdenum disulfide components in high strength bolting applications.	(1) This item is part of its LR Commitment #15. Check and confirm the status of this item. (2) Does the RNP AMP B.3.4 depend only on the material specification for identifying its high-strength bolting with yield strength > 150 ksi, or does it utilize actual measured yield strength values?
3. Parameters Monitored/ Inspected	Enhancement to this program element will include inspection and evaluation of high-strength bolting on one motor-operated valve (MOV) prior to the PEO.	(1) This item is part of its LR Commitment #15.
4. Detection of Aging		No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Effects		
5. Monitoring and Trending		No significant issue or further review item was identified.
6. Acceptance Criteria		No significant issue or further review item was identified.
7. Corrective Actions		No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience		No significant issue or further review item was identified.

B.9.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

The EPRI NMAC study has reconciled and consolidated the various earlier EPRI/industry guidelines documents into two EPRI reports (1015336 and 1015337). The oldest two-volume EPRI NP-5067 report has been removed from normal access (archived only for reference) and the EPRI TR-104213 has been replaced with the new guidance documents. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): include in references.

B.9.5. Documents Reviewed during the Audit

1. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
2. EPRI 1015336
3. EPRI 1015337
4. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
5. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
6. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004

B.9.6. Summary

Robinson LRA Section B.3.4 summarizes RNP's implementation of the associated GALL AMP XI.M18 – Bolting Integrity (Rev. 0 of GALL Report, 2001). The RNP AMP B.3.4, as well as staff's SER (NUREG-1785) note that the LRA AMP is consistent with the associated GALL Report AMP XI.M18, with exceptions to scope of program and inspection needs and requirements for monitoring cracking in high strength bolting of NSSS supports. The RNP AMP B.3.4 has enhancements to its Preventive Actions element and its Parameters Monitored/Inspected element. The RNP Bolting Integrity AMP itself relies on other RNP AMPs.

The enhancements, as noted in LRA section A.3.1.12 and in the staff's LRA Inspection Report (NRC IR 2003009), include (a) bolting requirements and inspections for the reactor coolant pump cover to casing bolts in its Preventive Maintenance AMP, and (b) the use of molybdenum sulfide would be added to the site's bolting procedure. The exception to scope of program excludes AMR items for structural bolting to be managed under this AMP, which is consistent with the (current) Rev. 2 of GALL Report, provided the AMR items are crediting other relevant AMPs for these bolting. Staff's Post-approval Site Inspection for License Renewal Inspection Report (NRC IR 2010008) confirmed that RNP had completed the necessary actions on its related commitment prior to the start of the PEO.

The staff reviewed the status and implementation results of RNP's AMP for bolting integrity. RNP confirmed that its AMP for bolting integrity relies entirely on other AMPs, including its ASME Code Section XI ISI AMP.

RNP noted that it expects that fleet-level requirements/procedures may be forthcoming and that any issues or inconsistencies in its current AMP will also be addressed in the fleet initiative, which would be incorporated in the RNP AMP. In response to staff's query about assessing the effectiveness of RNP's bolting AMP RNP also indicated that such assessment becomes difficult due to the scattered nature of its program that relies on its corrective actions program (CAP) and related varied maintenance activities.

It is clear that the original intent and motivation for a separate bolting integrity program may not be satisfactorily met if there is no consolidated (dedicated) implementation to do so, and the AMP effectiveness is hard to assess in such a case.

With regard to the basis documents, the EPRI NMAC study has reconciled and consolidated the various earlier EPRI/industry guidelines documents into two EPRI reports (1015336 and 1015337). The oldest two-volume EPRI NP-5067 report has been removed from normal access (archived only for reference) and the EPRI TR-104213 has been replaced with the new guidance documents. The staff noted that RNP's review and updating, or self-assessment activity, of its AMP B.3.4 did not incorporate these industry updated guidelines, which suggests the need for better guidance, at least in some AMPs, on timely and effective updating of AMP implementations in relation to the related industry activities and programs.

B.10 Steam Generator Tube Integrity Program (LRA Section B.2.4)

Associated GALL Report AMP: **2001 GALL Report, XI.M19 Steam Generator Tube Integrity**

B.10.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.2.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to this element are not expected. If there is an issue, include pertinent text from the program description.	No significant issue or further review item was identified.
1. Scope of Program	The RNP AMP B.2.4 is consistent with the associated GALL Report AMP XI.M19, Steam Generator Tube Integrity (SGTI). At RNP, the AMP is performed under its overall Steam Generator Program (PLP-114) which is a site-specific program incorporating the NEI 97-06 industry guidance for SGTI. The SGTI AMP at RNP specifies inspection scope, frequency, and acceptance criteria for the plugging and repair of flawed SG tubes, in accordance with the plant technical specifications and the guidance of NEI 97-06. In addition to SGs tubes, other components – tube plugs, tube support plates and anti-vibration bars in the SGs – are inspected under this program. The RNP SGTI program includes loss of material due to crevice and pitting corrosion of the tube plugs, loss of material due to crevice corrosion, erosion, pitting corrosion and cracking due to SCC of the tube support plates.	RNP LR Commitment #7 specified that the existing SGTI AMP would be credited for aging management of the steam generator tube bundle, tube plugs, tube support plates and anti-vibration bars in the steam generators at RNP. The current industry guidelines, dated January 2011, are in the Revision 3 of NEI 97-06. The changes in Rev. 3 of NEI 97-06 include (a) removal of "requirements" in NEI 97-06, which are located in other industry documents (e.g., NEI 03-08 and the EPRI guidelines referenced in NEI 97-06), (b) corrections to definitions, and (c) corrections for inconsistencies with requirements in the technical specifications. These are significant changes for AMP implementation. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Does AMP need to be updated to include these other EPRI docs? And how they are used? NEI 97-06 Rev. 2 is what is in the AMP now.
2. Preventive Actions		No significant issue or further review item was identified.
3. Parameters Monitored/		

Program Element	Element of Licensee's AMP (LRA Section B.2.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Inspected		
4. Detection of Aging Effects		In this program element, the absence of formal inclusion and discussion of effective means of detection of degradation in the (cladded) tubesheet, divide plate, tube-ends, and associated weld (HAZ) locations are of concern. There is no well-qualified eddy current inspection technique at present for these welds, adding inspectability concerns to the associated potential PWSCC issue. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Add these two items to SLR-GDs.
5. Monitoring and Trending		
6. Acceptance Criteria		No significant issue or further review item was identified.
7. Corrective Actions		No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	RNP will continue to evaluate and implement new guidance provided by future revisions of NEI 97-06. The program is continually updated based on industry experience and self-assessment programs.	RNP will continue to evaluate and implement new guidance from future revisions to NEI 97-06, after determining if exceptions are needed. The implementation of SGTI AMP at RNP includes tube plugs, tube support plates and anti-vibration bars in the SGs which are inspected for loss of material due to crevice corrosion and pitting corrosion of the tube plugs, loss of material due to crevice corrosion, erosion, pitting corrosion

Program Element	Element of Licensee's AMP (LRA Section B.2.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		and cracking due to SCC of the tube support plates.

B.10.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

1. For the Tech Spec changes related to alternate repair criteria (ARC), NRC staff confirmed that there are no time limited aging assumptions (e.g., SG performance degradation due to level of plugging) involved. .

B.10.5. Documents Reviewed during the Audit

1. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
2. EPRI 1012984, Technical Basis for SG Tube Integrity Performance Acceptance Standards.
3. EPRI 1022830, Investigation of Steam Generator Secondary-Side Degradation.
4. EPRI 1022831, Onset of Fatigue Cracking in Steam Generator Tubes with Through Wall Flaws.
5. EPRI 1025133, Assessment of Channel Head Susceptibility to PWSCC.
6. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
7. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
8. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
9. NEI 03-08
10. NEI 97-06, Rev. 3, Nuclear Energy Institute, Steam Generator Program Guidelines, January 2011.
11. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
12. PLP-114
13. Program Health Report, RNP Steam Generator (7/1/2012 – 9/30/2012), 12/3/2012.
14. RNP-RA/09-0103, Request for Technical Specifications Change Regarding Steam Generator Alternate Repair Criteria, RNPSEP, Unit 2, ADAMS ML093631212, 12/16/2009.
15. RNP Technical Specifications

B.10.6. Summary

Robinson LRA Section B.2.4 summarizes RNP's implementation of the associated GALL AMP XI.M19 – Steam Generator Tube Integrity (Rev. 0 of GALL Report, 2001). The RNP AMP B.2.4 and staff's SER (NUREG-1785) note that the LRA AMP is consistent with the associated GALL Report AMP XI.M19. At RNP, the AMP is performed under its overall Steam Generator Program (PLP-114) which is a site-specific program incorporating the NEI 97-06 industry guidance for steam generator tube integrity (SGTI). The SGTI AMP at RNP specifies inspection scope, frequency, and acceptance criteria for the plugging and repair of flawed SG tubes in accordance with the plant technical specifications and the guidance of NEI 97-06; in addition to SGs tubes other components – tube plugs, tube support plates and anti-vibration bars in the SGs – are inspected under this program, meeting its LR Commitment #7. Staff's Post-approval Site Inspection for License Renewal Inspection Report (NRC IR 201008) confirmed that RNP had completed the necessary actions on its related commitment prior to the start of the PEO.

The staff reviewed the status of RNP's AMP B.2.4 and discussed its implementation results with the RNP personnel. RNP noted that the AMP is performed under its overall Steam Generator Program (PLP-114) which is a site-specific program based on the industry guidance documented in NEI 97-06 as incorporated in RNP's Technical Specifications (TS). The staff enquired about the revision of NEI 97-06 for this implementation; RNP personnel noted it to be most likely the latest, but expected that any updated guidance will be provided in fleet (Duke) program to be followed in the near future, and that any changes or updates to resolve inconsistencies and incorporate latest industry experience/guidance will be through the fleet program.

The staff also enquired about the recent TS changes regarding frequency and extent of certain inspections under its SGTI AMP, and whether the changes were one-time or permanent. RNP indicated that certain changes (H* related) to its TS are now expected to be permanent and not limited to one-time (or temporary) ARC to limit the inspections for certain tube portions within the tubesheet. With regard to staff's query, RNP also indicated that any operational leakage from the uninspected portions of the primary pressure boundary of SGs, as estimated in the past and as expected in future operation, was unlikely to be of significance for maintaining the leakage integrity of SGs. However, it was not immediately apparent (or confirmed), whether the basis for these TS changes involved any time-limited assumptions.

The staff requested details of RNP's latest self-assessment of its SGTI AMP, and the frequency of assessment planned during the PEO. RNP provided the results of its latest program assessment to the staff for review, and noted that RNP expects the frequency of self-assessment for its SGTI AMP to be about every 5 years. The latest self-assessment, in May 2010, was performed in order to support a constantly improving steam generator program which identified 1 deficiency and 4 recommendations. The deficiency was attributed to presence of foreign objects (on the secondary side) resulting in additional dose, time/schedule impact and cost during the outage, which is

not directly related to aging effects, and likewise the recommendations were of no significance to the aging management program elements. The latest (3rd quarter 2012) Health Report on SG Program suggested that the tube damage due to foreign objects was the only reason for tube plugging in the recent outages-related inspections, and the frequency of this plugging showed an increasing trend with time. The related corrective actions included removal of spiral wound gaskets from secondary systems, and improvements to the foreign material program. The report also noted that RNP has a significant buildup of deposits on the top-of-tube sheet and in the upper tube bundle, which could result in loss of function (full power operation) if not addressed more effectively, and that full bundle secondary side chemical cleaning and utilization of dispersants, to reduce the rate of iron deposition, were planned actions.

RNP personnel expressed the view that the industry guidance is less specific for the secondary side inspections and degradation assessment. RNP includes any replacement components in its SGTI AMP as well as the degradation assessment (DA) report for steam dome area. Also, tubesheet cladding and AVB inspections, mostly visual, are included in RNP's SGTI AMP. RNP continues to note sludge-pile build-up and that, although tube-end cracking has been a common industry-wide occurrence, it is not considered significant to structural and leakage integrity performance criteria for the SGs.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): As a follow-up to the audit, the staff noted that EPRI guidance requires utilities to develop and implement secondary side inspections and secondary side integrity assessments, including SG internals, such that the tube safety functions are not compromised by the secondary side internals degradation. The above view, expressed by the RNP personnel and the EPRI requirement, suggests that the GALL Report should incorporate the related observations in its guidance and/or consider interim staff guidance (ISG). In this connection, the staff notes that under the "Detection of Aging Effects" program element of GALL AMP, the absence of formal inclusion and discussion of effective means of detection of degradation in the (cladded) tubesheet, divide plate, tube-ends, and associated weld (HAZ) locations are of concern. There is no well-qualified eddy current inspection technique at present for these welds, adding inspectability concerns to the associated potential PWSCC issue.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): It would be useful for the staff to review EPRI Technical Reports 1022831 (Onset of Fatigue Cracking in Steam Generator Tubes with Through Wall Flaws), 1025133 (Assessment of Channel Head Susceptibility to PWSCC), 1022830 (Investigation of Steam Generator Secondary-Side Degradation), and 1012984 (Technical Basis for SG Tube Integrity Performance Acceptance Standards), and incorporate findings from these into the applicable program elements of the GALL Report AMP.

B.11 Open Cycle Cooling Water System Program (LRA Section B.3.5)

Associated GALL Report AMP: **2001 GALL Report, XI.M20 Open Cycle Cooling Water System**

B.11.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	RNP maintains a formal plant program for oversight of the plant's commitments to GL 89-13. This program, identified as the "Cooling Water Reliability Program (GL 89-13), generally corresponds to the Open Cycle Cooling Water System AMP described in GALL, Section XI.M20. The RNP Cooling Water Reliability Program forms the basis for the Open Cycle Cooling Water (OCCW) System Program. Robinson has a number of programs to manage, sample, and maintain the OCCW System, the Service Water System (SW), and associated interfacing system points. The SW flows from Lake Robinson to the cooling loads necessary for safe shutdown and emergency core cooling equipment support. The non-safety portion of the system cools main turbine loads during normal plant operations. The inspectors reviewed several of the procedures the applicant credited for the program. Additionally, the SW system had recently been inspected by the NRC in April 2002 (inspection report 50-261/2002-002) and was found acceptable at that time. As an enhancement, the applicant was planning to write a PM item to replace the safety related pump room cooling coils on a repetitive basis. Routinely, the plant engineering personnel had been replacing the coils on a three-year periodicity to account for coil tube wall loss (see Program Element 2 below). The PM action was to ensure routine nature of	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	the replacement would continue. Plant engineering was considering other possibilities for the enhancement, such as replacement of the 90 percent copper coils with stainless steel coils.	
1. Scope of Program	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL. At RNP, the OCCW System Program addresses that part of the SW System within the scope of license renewal, including SW cooled components in other plant systems. It specifically includes aging management of Component Cooling Water (CCW) heat exchanger subcomponents that are in contact with raw water.	The most recent revision of the EPRI Open Cooling Water Chemistry Guideline is EPRI 1025318, published in September of 2012. This replaces EPRI TR-106229 published in 1996. What guidance is currently used at Robinson? **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Note update guidance given in GALL, Rev. 2, p. XI.3 for EPRI 1025318.
2. Preventive Actions	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL. However, the Robinson LRA (Commitment #16) states that this program will be enhanced to initiate an action under the site Preventive Maintenance Program (LRA AMP B.3.18), to periodically replace cooling coils in certain room coolers with stainless steel coils. Eddy current inspections are to be conducted on a 6-year frequency.	
3. Parameters Monitored/ Inspected	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL. It goes on to state that, notably, corrosion coupons were installed in 1990 to address corrosion concerns identified in NRC GL 89-13. A corrosion coupon-monitoring program was maintained for several operating cycles to predict corrosion rates and verify the effectiveness of chemical addition in mitigating MIC. Test results showed negligible corrosion of stainless steel coupons, approximately 1 to 2 mils/year for certain copper alloys, and no significant	Note that heat exchanger performance at Robinson is verified by regular inspections/cleaning in accordance with EPRI guidance, as an alternative to heat transfer testing called for in GALL AMP XI.M20 and NRC GL 89-13. (See program element 5).

Program Element	Element of Licensee's AMP (LRA Section B.3.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	biological growth	
4. Detection of Aging Effects	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL. The Robinson LRA states that this program will be enhanced by incorporating, into the One-Time Inspection Program (LRA AMP B.4.4), a requirement to perform a one-time volumetric inspection of the CCW heat exchanger tubes, prior to the end of the current license period. Results from this inspection will be used to determine the need for inspections/testing over the period of extended operation. RNP-L/LR-0602 states that the CCW heat exchangers were re-tubed in 1990 due to tube degradation arising from galvanic corrosion, erosion/corrosion, and fatigue. The heat exchanger repairs included replacement of the degraded admiralty brass tubes with 90/10 copper-nickel, and coating the inlet water boxes with an epoxy coating.	
5. Monitoring and Trending	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL. Heat exchanger performance is verified by regular inspections/cleaning in accordance with EPRI guidance, as allowed as an alternative to heat transfer testing for GL 89-13.	No significant issue or further review item was identified.
6. Acceptance Criteria	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL. Chlorination is used to control biological fouling.	No significant issue or further review item was identified.
7. Corrective Actions	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL.	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
8. Confirmation Process	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	RNP-L/LR-0602 ("Aging Management Program, Open-Cycle Cooling Water System Program, Rev. 7") states that this program element is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	Several OE events occurred at Robinson, primarily in early plant operations that impacted the Service Water System (LERs 83-003-00, 83-022-00, 87-029-00, and 92-015-00).	Comment on recent operating experience, particularly subsequent to license renewal. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Additional OE references. NRC IN 2006-17, "Recent Operating Experience of Service Water Systems Due to External Conditions," issued in July of 2006, notes incidents of reduced flow in service water systems at Cooper and Watts Bar due to clogging of intake screens by silt, sand, and small rocks. Similarly, IN 2004-07 "Plugging of Safety Injection Pump Lubrication Oil Coolers with Lakeweed," issued in April of 2004 describes plugging of the high-pressure safety injection pump lubrication oil coolers at Kewaunee with lakeweed. Both of these INs were released after the Robinson LRA was submitted. Have similar problems been experienced at Robinson, and what precautions (beyond those measures taken in response to GL 89-13) are taken to prevent such occurrences? Note also the following related generic communications: IN 92-49, "Recent Loss Or Severe Degradation Of Service Water Systems," July 2, 1992. IN 2007-06, "Potential Common Cause Vulnerabilities in Essential Service Water Systems," February 9, 2007.

B.11.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.11.5. Documents Reviewed during the Audit

1. EPRI TR-106229
2. EPRI 1010059
3. EPRI 1025318
4. GL 89-13, Service Water System Problems Affecting Safety-Related Equipment, 7-18-1989.
5. IN 2004-07, Plugging of Safety Injection Pump Lubrication Oil Coolers with Lakeweed, 4-7-2004.
6. IN 2006-17, Recent Operating Experience of Service Water Systems Due to External Conditions, 7-31-2006.
7. IN 2007-06, Potential Common Cause Vulnerabilities in Essential Service Water Systems, 2-9-2007.
8. IN 2007-28, Potential Common Cause Vulnerabilities in Essential Service Water Systems Due to Inadequate Chemistry Controls, 9-17-2007.
9. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, 4-7-2010.
10. LER 83-003-00, Service Water Leak in Containment Fan Cooler, 4-22-1983.
11. LER 83-022-00, Service Water Leak in Containment Fan Cooler, 9-02-1983.
12. LER 87-029-00, Service Water Flange Leak in Containment; Minimum Component Redundancy Violation, 12-17-1987.
13. LER 92-015-00, Seismically Inoperable Service Water System due to Corroded Piping, 8-27-1993.
14. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
15. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
16. RNP-L/LR-0602, Rev. 7, Aging Management Program, Open Cycle Cooling Water System Program, 6-23-2004.

B.11.6. Summary

RNP implements this program through its Open-Cycle Cooling Water Program (AMP B.3.5), also identified at Robinson as the “Cooling Water Reliability Program (GL 89-13).” The Robinson LRA states that this program generally corresponds to GALL, Revision 0, AMP XI.M20 (“Open Cycle Cooling Water System”). The Robinson Cooling Water Reliability Program forms the basis for the Open-Cycle Cooling Water System Program.

As a result of license renewal review, an enhancement was made to initiate an action under the site Preventive Maintenance Program to periodically replace cooling coils in certain room coolers. The old copper tubes were replaced with tubes fabricated of the austenitic alloy AL-6XN. Also, a requirement to perform a one-time volumetric inspection of the CCW heat exchanger tubes, prior to the end of the current license period, was incorporated into the One-Time Inspection Program. This activity is also described in the summary for the One-Time Inspection Program. In addition to the above, the four containment air coolers, which had been replaced in 1990, are being inspected by eddy current technology (ECT) on a rotating basis, with one inspection during each outage. No problems have been detected to date.

In response to a reviewer’s question, RNP stated that their service water was obtained from Lake Robinson, and that the only treatment applied was chlorination and screening to remove larger particles. In particular, they did not follow EPRI service water quality guidelines (EPRI 1025318 and EPRI 1010059), nor are these guidelines referenced in any of the revisions of the GALL Report.

During the audit, RNP stated that their Service Water System had experienced numerous problems during early plant operations and that RNP was a “poster child” for NRC GL-89-13. This is borne out by early operating experience, as described in LERs 83-003-00 (“Service Water Leak in Containment Fan Cooler HVH-3”), 83-022-00 (“Service Water Leak in Containment Fan Cooler HVH-2”), and 87-029-00 (“Service Water Flange Leak in Containment”). However, RNP stated that these problems had been vigorously addressed, and the license renewal SER in 2004 noted no significant deficiencies in the program.

Subsequent to license renewal, there have been a couple of OE events of note. These events are mentioned in the Service Water System Health Report for the Third Quarter of 2012 (Dec. 3, 2012) and were further discussed during the audit. The first of these involves the underground main headers, which are the primary supply and return lines for the service water system. These lines are fabricated of carbon steel with an inner concrete mortar lining approximately 3/8-in. thick. In recent years, small pieces of the mortar lining have spalled off and become embedded in the “B” closed-cycle cooling water heat exchanger. A repair order was put in place for the north header, which was determined to be the source of the problem. Repair alternatives include coating or re-lining the inner surface of the piping to stabilize the mortar lining, or both headers may be replaced with above-ground piping. RNP stated the both headers were inspected internally in 1990; the north header has been inspected three times since then and the south header is to be inspected for the first time since 1990 during the next outage. The headers are approximately 900 to 1000 feet in length.

Another problem that has arisen is higher than normal vibration in service water pump “C.” Spectral analysis of the vibration signature has determined that the vibration is not due to an internal balance problem (e.g., a degraded impeller), but rather improper mounting and shimming. A pump base redesign has been developed and is to be put into place.

RNP also stated that all of the old rubber-lined aluminum service water piping providing cooling water to the diesel generators has been replaced with stainless steel piping because of leakage problems. In addition, all of the service water carbon steel heat exchanger surfaces have been coated to control corrosion, and the coating of choice is Chesterton ARC855, a polymer ceramic coating.

This AMP appears to be functioning effectively in that it is identifying and addressing aging-related problems.

B.12 Closed Cycle (Component) Cooling Water System Program (LRA Section B.2.5)

Associated GALL Report AMP: **2001 GALL Report, XI.M21A Closed Treated Water System**

B.12.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.2.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The applicant has two closed cycle systems that were included in this program. These were the component cooling water and the emergency diesel generator cooling systems, both of which are cooled by the open cycle cooling water system. Component cooling water and emergency diesel generator coolant contain a chromate mixture that prevents bacterial growth and inhibits corrosion of the metal of the closed systems. The component cooling water cools components such as the high head injection pumps' bearings and the RHR heat exchangers, while the emergency diesel generator cooling cools the emergency diesel generator engine and engine oil. The water chemistry procedures reference the EPRI guidance used throughout the industry.	The most recent version of the EPRI Closed Cycle Cooling Water Chemistry Guideline is EPRI 1007820 (2004), which is Rev. 1 of EPRI TR-107396. However, a new revision of the Closed Cycle Cooling Water Chemistry Guideline is to be published in late 2013. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Update GALL to latest EPRI guideline.
1. Scope of Program	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL. However, the following apparent exceptions and enhancements are noted: 1. The RNP AMP lists a number of components not specifically addressed in GALL that are covered by the RNP CCCW System Program. 2. In addition to those aging mechanisms listed in GALL, the RNP CCCW System Program is credited with management of cracking due to SCC and loss of heat transfer effectiveness	See above

Program Element	Element of Licensee's AMP (LRA Section B.2.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	3. Selective leaching of CCCW System components exposed to treated water at RNP is managed by cooling water chemistry, which utilizes corrosion inhibitors to protect base metal from electrochemical reactions. Selective leaching of raw water components is addressed by the RNP Selective Leaching Program.	
2. Preventive Actions	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL. The use of chromate water chemistry in the component cooling water and emergency diesel generator jacket water is specifically noted. In addition, testing/inspection of the component cooling water heat exchangers is addressed under the RNP Open Cycle Cooling Water System Program. Regular physical inspections of the tube (raw water) side of these heat exchangers are stated to manage loss of heat transfer from fouling. A one-time inspection (eddy current) of the component cooling water heat exchanger tubes was to be performed to address the potential for erosion.	According to the RNP "One Time Inspection Program License Renewal Commitment" document, the B component cooling water heat exchanger was re-tubed during RO-025. A population of the existing tubes were pulled and measured to obtain the "as found" tube wall. From this data, it was determined that the A component cooling water heat exchanger should also be re-tubed during RO-26. This was completed, and tube wear was found to be as predicted. Preventive maintenance activities have been established to perform eddy current testing for both heat exchangers on a 6-year frequency
4. Detection of Aging Effects	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL. Cooling system components associated with the diesel generators are inspected on a regular basis. Component Cooling Water and Emergency Diesel Generator jacket water is tested monthly, and the component cooling water heat exchanger and emergency diesel generator jacket water and after cooler tubesheets are regularly inspected. Safety-related components of the Component Cooling Water System and Emergency Diesel Generators are	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.2.5)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	subject to regular testing to verify Technical Specifications requirements regarding system operability are satisfied, and dedicated shutdown diesel generator, and EOF/TSC (emergency operations facility/technical support center) diesel are subject to regular performance testing.	
5. Monitoring and Trending	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
6. Acceptance Criteria	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
7. Corrective Actions	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
8. Confirmation Process	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	RNP-L/LR-0627 ("Aging Management Program, Closed-Cycle Cooling Water System, Rev. 2") states that this program element is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The RNP SER notes that the applicant's operating experience identified wall thinning due to erosion in component cooling water piping downstream of spent fuel pool heat exchangers. This condition was addressed by replacing the thinned piping and a plan to implement periodic surveillance to monitor wall thickness in the future under the Preventive Maintenance Program.	The component cooling water System Health Report (3Q 2012) states that "FIC-658 has erratic indication and the controlotron is providing indication. Permanent repair is scheduled for RO-28." In addition, "Both component cooling water heat exchangers have been re-tubed but need to be re-coated. Work orders are in place with plans to recoat CCW-HTX-A in RO28."

B.12.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.12.5. Documents Reviewed during the Audit

1. EPRI 1007820, (Rev. 1 of EPRI TR-107396), 2004.
2. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
3. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
4. One Time Inspection Program License Renewal Commitment.
5. Program Health Report, Component Cooling Water, 3Q 2012
6. RNP-L/LR-0627, Rev. 2, Aging Management Program, Closed-Cycle Cooling Water System, 6-23-2004.

B.12.6. Summary

RNP implements this program through its Closed-Cycle Cooling Water System Program (AMP B.2.5). This is an existing AMP that is used to manage selected components in the Component Cooling Water (CCW) System and Diesel Generator Systems. The aging effects/mechanisms of concern are loss of material due to crevice, general, pitting and galvanic corrosion, loss of heat transfer due to fouling, cracking due to SCC, and loss of material due to selective leaching. The RNP LRA states that this program is consistent with GALL, Revision 0, AMP XI.M21 ("Closed-Cycle Cooling Water").

During the audit, RNP confirmed that the program follows EPRI guidance on closed-cycle cooling water chemistry as endorsed in GALL, Rev. 0 AMP XI.M21 and that this guidance is updated as new guidance is published by EPRI and approved by the NRC. They are currently following EPRI 1007820, which was published in 2004. The component cooling water and emergency diesel generator jacket water employ chromate chemistry. The dedicated shutdown and Emergency Operations Facility/Technical Support Center Building Security Diesel Generator jacket water utilizes a glycol solution supplemented with corrosion inhibitors.

According to the RNP "One Time Inspection Program License Renewal Commitment" document, the "B" CCW heat exchanger was re-tubed (with AL-6XN tubes) during RO-25. A population of the existing tubes were pulled and measured to obtain the "as found" tube wall. From this data it was determined that the "A" CCW heat exchanger should also be re-tubed during RO-26. This was completed, and tube

wear was found to be as predicted. Preventive maintenance activities have been established to perform eddy current testing for both heat exchangers on a 6-year frequency. This is also discussed under the One-Time Inspection AMP.

This AMP appears to be functioning effectively in that it is identifying and addressing aging-related problems.

B.13 Inspection of Overhead Heavy Load and Light Load Handling System Program (LRA Section B.3.6)

Associated GALL Report AMP: **2001 GALL Report, XI.M23 Inspection of Heavy and Light Load (Related to Refueling) Handling Systems**

B.13.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The program provides guidelines and inspection attributes for monitoring the physical condition of the crane structures within the scope of License Renewal. Rails and girders are visually inspected on a routine basis for degradation. Functional testing requirements are specified. These cranes must also comply with the maintenance rule requirements in 10 CFR 50.65.	LRA section A.3.1.14 Inspection of Overhead Heavy Load and Light Load Handling states that administrative controls for Inspection of Overhead Heavy Load and Light Load Handling equipment will be enhanced, prior to the period of extended operation, to include requirements for inspecting the Turbine Gantry Crane in addition to the other cranes that require inspection, and notes that cranes are to be inspected using the attribute inspection checklist for structures.
1. Scope of Program	The Overhead Heavy and Light Load Handling Systems Program is credited for aging management of the following crane lifting devices at RNP: • Containment Polar Crane • Spent Fuel Cask Crane • Turbine Gantry Crane • Spent Fuel Bridge Crane The aging effect/mechanism of concern is loss of material due to corrosion.	No significant issue or further review item was identified.
2. Preventive Actions	This is an inspection program and no actions are taken as part of this program to prevent or mitigate aging degradation.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected		No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
4. Detection of Aging Effects	Crane rails and structural components for the Polar Crane, Spent Fuel Cask Crane, and Spent Fuel Bridge Crane are visually inspected in accordance with EGR-NGGC-0351 and documented to TMM-104. The Turbine Gantry Crane is periodically inspected and TMM-104 will be revised to include it as a system requiring inspection.	No significant issue or further review item was identified.
5. Monitoring and Trending		In GALL VII B table, there is no outdoor environment for crane systems. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Add outdoor environment, or would it be handled as an exception to the GALL?
6. Acceptance Criteria	A set of inspection attributes and acceptance standards are provided for the crane structure and supporting structures.	No significant issue or further review item was identified.
7. Corrective Actions	Condition Monitoring of Structures (EGR-NGGC-0351) requires the user to initiate a Condition Report for any condition identified as "Unacceptable". Condition Reports are controlled as part of the Corrective Action Program (CAP-NGGC-0200) in accordance with 10CFR part 50, Appendix B.	No significant issue or further review item was identified.
8. Confirmation Process	Corporate and Site Quality Assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50 and will continue to be adequate for the period of extended operation.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	Same as above	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The four cranes in scope for license renewal are periodically inspected to satisfy the ANSI B30.2 and NUREG-0612 requirements for inspection attributes such	**1.** Three significant wire rope failure OE cases are described in NRC IN 2009-20, "Degradation of Wire Rope Used in Fuel Handling Applications." **ACTION ITEM for**

Program Element	Element of Licensee's AMP (LRA Section B.3.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	as steel member corrosion, damaged members or connections, baseplate or anchor bolt corrosion, damaged or degraded grout pads, structure geometry to include absence of excessive deflection, cross section distortion, or member misalignment, missing parts, coat deficiencies, and structural cracking. Inspections are documented on a System Walkdown report. In RNP crane quick-hit self-assessment (Form CAP-NGGC-0201-8-17) in Feb. 2012, Three deficiencies were identified as: Deficiencies in the Engineering Change Process. Deficiencies in Materials Management Inappropriate basis for deletion of tests out of Preventive Maintenance procedure. These, however, are not aging related. External EPIX OE applicable to RNP fuel handling equipment and polar and gantry cranes is reviewed. The amount of failures applicable to RNP cranes is insignificant. The majority of the equipment failures identified from the search dealt with shear pins that have experienced dezincification, due to being submerged in borated water for an extended period.	**Consideration for writing SLR-GDs** (as result of audit): Add this reference. (a) In January 2009, the LaSalle station experienced a partial failure (broken wire strands) of one of two wire ropes in the refueling machine. The broken wire strands occurred at a point that was subject to bending and was difficult to inspect because it was located at an end fitting. The failure was caused by fatigue. Failure of both of the redundant wire ropes could result in release of radioactive material. Corrective actions included fleet-wide inspection of wire rope in similar use and establishment of a program to replace these wire ropes on a specified frequency. (b) In October 2007, the Beaver Valley station experienced a complete failure of the sole wire with a new fuel assembly in the up-ender. The failure occurred at a wire location that was subject to repeated bending around too closely spaced sheaves, and difficult to inspect because of the underwater location near the sheaves. Failure was caused by fatigue and could result in a release of radioactive material. Corrective actions included establishing new repetitive preventive-maintenance tasks to perform fuel transfer equipment cable and sheave inspections. (c) On October 4, 2007, the Browns Ferry station experienced a distortion (untwisting) of the wire rope structure in one of the two redundant reeving systems that support heavy loads moved on the refueling floor. Distortion of the wire rope structure increased the potential for failure under load as the individual strands are less likely to share the load evenly. An enhanced inspection schedule was established to monitor the condition of the wire rope until the distorted rope could be replaced. **2.** In RNP crane quick-hit self-assessment (Form CAP-

Program Element	Element of Licensee's AMP (LRA Section B.3.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		NGGC-0201-8-17) in Feb. 2012, it states: RNP's Polar Crane failure challenged RNP's ability to execute the planned refueling as scheduled. As a result, any further issues with the Polar Crane or Fuel Handling equipment will directly impact critical path. An emergent self-assessment team was formed using personnel from other sites to perform an in-depth review of the Fuel Handling equipment, Polar Crane and Turbine Gantry Crane to assess vulnerabilities and mitigating strategies. Verify RNP's Polar Crane failure is aging related? **3.** In RNP crane quick-hit self-assessment (Form CAP-NGGC-0201-8-17) in Feb. 2012, it states: Reviewed approximately 12 year history available in EDB of corrective and preventive maintenance work orders for the Polar, T-G gantry cranes, and Spent Fuel Pool Bridge to identify components that have had repeat problems and regular parts usage. The most recurring problems dealt with the automatic rail clamps and the hydraulic bridge brakes on the turbine crane. The self-assessment recommended modifying/removing automatic rail clamps to prevent the maintenance burden. **4.** In RNP crane quick-hit self-assessment (Form CAP-NGGC-0201-8-17) in Feb. 2012, it states: Recent OE #35179 was reviewed since it applies to electrical failures (one of the most susceptible failures identified). The OE discussed an event where a fault occurred, due to a fault in a section of degraded wiring. The fault caused the crane to become inoperable, and resulted in outage delays. The degraded wire was caused by aging and harsh environment.

Program Element	Element of Licensee's AMP (LRA Section B.3.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		<u>ACTION ITEM</u> for Consideration for writing SLR-GDs (as result of audit): Recommend including degraded wiring and motor insulation as line items in the GALL AMR Table VII. B Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems. **5.** In RNP crane quick-hit self-assessment (Form CAP-NGGC-0201-8-17) in Feb. 2012, it states: External EPIX OE applicable to RNP fuel handling equipment, polar and gantry cranes is reviewed. The amount of failures applicable to RNP cranes is insignificant. The majority of the equipment failures identified from the search dealt with shear pins that have experienced dezincification due to being submerged in borated water for an extended period. At RNP, the pins and similar mechanical parts that are continuously submerged under borated water are the parts on the Spent Fuel Pool side. The flooded portion on the containment vessel (CV) side only contains water during outage periods. Therefore, these parts would be submerged for a shorter period. This is not to say that they are not susceptible to dezincification. Only, they may require a longer period between preventive maintenance. The Self-Assessment recommended replacing bushings, shear pins, etc. that are submerged in borated water. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Based on the OE, It is recommended to include in GALL of loss of material due to dezincification (loss of zinc from brass) of submerged crane components exposed to borated water environment in the spent fuel pool. The GALL XI. M33 Selective Leaching may be used for managing this aging effect. Otherwise, XI.M23 needs modification for inspection of the frequently submerged crane components for detection of dezincification.

B.13.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.13.5. Documents Reviewed during the Audit

1. 10 CFR 50
2. 10 CFR 50.65, Maintenance Rule.
3. ANSI B30.2
4. CAP-NGGC-0200, Rev. 34, NGG Standard Procedure.
5. CAP-NGGC-0201-8-17, Cranes Self-Assessment 2012 (January 27, 2012 – February 10, 2012), Feb. 8, 2012
6. EGR-NGGC-0351, Rev. 18, Conditions Monitoring of Structures.
7. IN 2009-20, Degradation of Wire Rope Used in Fuel Handling Applications.
8. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
9. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
10. NUREG-0612
11. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
12. OE 35179
13. RNP-L/LR-0682, Rev. 2, Aging Management Program, Inspection for Overhead Heavy and Light Load Handling System Program.
14. TMM-104, System Walkdown Procedure.

B.13.6. Summary

RNP implements this program through its AMP B.3.6, “Inspection of Overhead Heavy Load and Light Load Handling System Program.” The program is credited for aging management of the following crane lifting devices at RNP:

- Containment Polar Crane
- Spent Fuel Cask Crane
- Turbine Gantry Crane
- Spent Fuel Bridge Crane

The aging effect/mechanism of concern is loss of material due to corrosion. This program was originally implemented for the Maintenance Rule. At the time of license renewal, the Turbine Gantry Crane was added as it was within the scope of License Renewal but outside the scope of the Maintenance Rule. The Turbine Gantry Crane and Spent Fuel Cask Crane are subject to a semi-annual preventive maintenance inspection. The inspection is performed annually for the Spent Fuel Bridge Crane and at a refueling Outage for the Polar Crane.

The staff found that trending in the System Health Report is declining due to continuing corrosion problems with regards to obsolescence, margin, and painting of the spent fuel cask crane. During the audit, RNP engineer explained that the spent fuel cask cranes are exposed to an outdoor environment that causes continuing corrosion, and some parts of crane are difficult to paint, due to inaccessibility. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): In GALL, there is no outdoor environment for crane systems. Based on this OE, the staff recommends adding outdoor environment for crane systems in GALL.

RNP conducted a review of operating experience in Institute of Nuclear Power Operations (INPO) Equipment Performance and Information Exchange (EPIX) database applicable to RNP fuel handling equipment and polar and gantry cranes. The amount of failures applicable to RNP cranes was insignificant. It was found that the majority of the failures identified from the search dealt with shear pins that have experienced dezincification (loss of zinc from brass), due to being submerged in borated spent fuel pool water for an extended period. At RNP, the pins and similar mechanical parts are continuously submerged in the spent fuel pool. The RNP Self-Assessment report recommended replacing bushings, shear pins, etc. that are submerged in the spent fuel pool. The shear pin is a safety device designed to shear off in case of mechanical overload, and dezincification is a process of selective leaching. Based on the OE, the staff recommends to argument the GALL XI. M33 Selective Leaching for managing dezincification of refueling handling system component submerged in the spent fuel pool.

The AMP review during the audit focused on the following three main topics:

1. During the session, RNP explained that the spent fuel cask cranes are exposed to outdoor environment that causes continuing corrosion. Some parts of the crane are difficult to paint due to inaccessibility. In GALL VII B table, there is no outdoor environment for crane systems. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): It is recommended to add an outdoor environment for crane systems.

2. Recent OE #35179 described in the RNP crane quick-hit self-assessment (Form CAP-NGGC-0201-8-17, Feb. 2012) discussed an event where a fault occurred, due to a fault in a section of degraded wiring in the crane system. The fault caused the crane to become

inoperable, and resulted in outage delays. The degraded wire was caused by aging and harsh environment. A recommendation based on BNP practice is to consider “meggering,” to identify potential degradation of wiring and motor insulation. RNP explained that the inoperable crane, due to a fault in the degraded wiring, is a function issue, not aging related.

3. RNP conducted a review of EPIX OE applicable to RNP fuel handling equipment, polar and gantry cranes. The amount of failures applicable to RNP cranes is insignificant. It was found that the majority of the equipment failures identified from the search dealt with shear pins that have experienced dezincification due to being submerged in borated water for an extended period. At RNP, the pins and similar mechanical parts that are continuously submerged under borated water are the parts on the Spent Fuel Pool side. The Self-Assessment recommended replacing bushings, shear pins, etc. that are submerged in borated water.

   In the audit, RNP explained that shear pens are parts of active components in the refueling equipment, and are thus not in the scope of license renewal. The explanation is questionable, since the shear pin is a safety device, designed to shear in the case of a mechanical overload. The shear pin, itself, does not move. Therefore, based on the OE, It is recommended to include in GALL the loss of material due to dezincification (loss of zinc from brass) of submerged crane components exposed to borated water environments in the spent fuel pool. The GALL AMP XI.M33 Selective Leaching may be augmented for managing selective leaching for crane components submerged in the spent fuel pool.

   The reviewers had several other concerns, which were resolved during the audit. These included the situation where three significant wire rope failure OE cases are described in NRC IN 2009-20, “Degradation of Wire Rope Used in Fuel Handling Applications.” RNP will examine the three cases for the applicability to their cranes within in the scope of license renewal.

Finally, during the audit, RNP engineer stated that they will examine the three significant crane failure cases in recent years for the applicability to their cranes as recommended by the staff. These three significant wire rope failure OE cases are documented in NRC IN 2009-20, “Degradation of Wire Rope Used in Fuel Handling Applications.”

B.14 Fire Protection (LRA Section B.3.1)

Associated GALL Report AMP: **2001 GALL Report, XI.M26 Fire Protection**

B.14.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The program is based on GALL Rev. 0 (NUREG-1801, Generic Aging Lessons Learned (GALL) Report, April 2001.) The Fire Protection Program manages the aging effects as applicable for fire barriers (fire barrier walls, ceilings, and floors, penetration seals and fire rated doors) and non-water-based fire suppression systems (halon and carbon dioxide). The Fire Protection Program requires periodic visual inspection of fire barrier penetration seals, and periodic visual inspection and functional tests of fire rated doors to ensure that their operability is maintained. The Program also includes periodic inspection and test of halon and carbon dioxide fire suppression systems. It includes pump testing in the aging management strategy for the diesel engine firewater pump fuel supply line. The diesel-driven fire pump inspection requirements require that the pump be periodically tested to ensure that the fuel supply line can perform the intended function. Enhancement: 1. *Inspection of fire barrier walls, ceilings, and floors*. Prior to the period of extended operation, the Fire Protection Program will be enhanced to note that concrete surface inspections performed under structures monitoring procedures will be credited for inspection of fire barrier	1. Verify the inspection results of the fire doors in last 5 years to justify applicant's semi-annual inspection frequency and make sure the inspection of fire barriers includes inspection of all fire barriers (e.g., fire wrap, fire resistance coating such as intumescing paint, cementitous material, etc.), not just penetration seals.] 2. The RNP Fire Protection AMP includes diesel-driven fire pump performance testing that is not included in GALL, Rev. 2. 3. IR 2010008 (April 7, 2010) states that: Fire Protection Program Commitment #12 specified that prior to the period of extended operation the existing Fire Protection Program will be credited and will be enhanced to note that concrete surface inspections performed under structures monitoring procedures are credited for inspection of fire barrier walls, ceilings, and floors. The required enhancement was originally added to the System Walkdown Procedure, TMM-104. The inspectors found that the enhancement was being moved to the Structural Inspection Procedure, EGRNGGC-0351. The licensee was tracking this action through Procedure Revision Request (PRR) 353128 and AR item 365673-09. At the time of this inspection, this commitment item was partially completed and additional tasks were pending to be implemented prior to the period of extended operation. The inspectors reviewed the existing procedures and draft proposed

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	walls, ceilings, and floors. Exception: 1. *Inspection frequency of fire doors*. GALL specifies bi-monthly inspections, whereas RNP performs detailed inspections semi-annually, augmented by frequent inspections during operator rounds and additional inspections under system/structural monitoring procedures. 2. *Inspection interval of fire barriers*. The inspection interval is based on safety significance of fire barriers, not to exceed 10 years, as compared to the refueling frequency specified by GALL. 3. *Valve alignment and system status* are not formally verified each month. Operator procedures check valve position and system status subsequent to any system realignments, and as needed to support plant operation. Current procedures/ practices deemed acceptable for the current license period are considered to be sufficient for the period of extended operation. 4. *Visual inspection criteria*: Inspection of fire barriers under systems and structures monitoring procedures are performed at a level of scrutiny deemed necessary by trained personnel to ensure operability, but are not specifically required on a level of detail commensurate with VT-1 inspections as in GALL.	procedures to verify that the program was implemented as stated in the commitment. Based on the review of licensee actions completed at the time of this inspection, the timeliness of those actions, and the administrative controls in place to track pending actions, the inspectors determined that there was reasonable assurance that the licensee would complete the necessary actions to meet Commitment #12. Verify the status of Commitment #12. Verify recent inspection results of the fire barriers and the inspection interval of fire barriers with safety significance. Ten-year interval appears too long for fire barriers. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): (1) Expand program description to include aging management of all fire barriers. (2) Expand program description to include more consideration of inspection results. Verify recent inspection results of the fire barriers and the inspection interval of fire barriers with safety significance. Ten-year interval appears too long for fire barriers
1. Scope of Program	Elastomer Flexible Hoses and Couplings (CO_2, Halon, CARDOX) are included in the applicant AMP. The applicant identified the following aging effects/mechanisms: Change in Material Properties from Elevated Temperature, and Cracking from Elevated Temperature	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): These components (elastomeric hose and couplings) are not addressed in the GALL Report. It is recommended to include these components (elastomeric hose and couplings of CO_2, Halon, and CARDOX system) in GALL. Note that fire penetration seals are in GALL Rev. 2 AMR line-items. (Note: CARDOX® carbon dioxide systems registered by

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	For the Fire Protection CO_2, Halon Supply System, and the Emergency Diesel Generator Cardox System, the Fire Protection Program manages the aging of flexible hoses and couplings. This program has traditionally accomplished these aging management activities. TMM-104, System Walkdown Procedure – credited with performing inspections of fire barriers. Also credited with performing system walkdowns for CO_2 (system 6195) and Halon (system 6205) Systems. EGR-NGGC-0351, Condition Monitoring of Structures - credited with specifying frequency of inspections associated with fire barriers (i.e., ceilings, walls, floors).	Chemetron Company is basically a CO_2 system.) Gaseous fire suppression option, CO_2 suppression system activated on photovoltaics. Verify the recent inspection results from System Walkdown on the CO_2 and Halon system. Verify the recent inspection results from Condition Monitoring of Structures on fire barriers. The AMP has one exception on the inspection interval of the fire barriers as mentioned above. It states that the inspection interval is based on the safety significance of fire barriers, not to exceed 10 years, as compared to the refueling frequency specified by GALL. EGR-NGGC-0351 states that: Periodic concrete (and masonry walls at RNP) inspections performed by this procedure are credited by the Fire Protection Program for inspection of fire barrier walls, ceilings, and floors. It appears that EGR-NGGC-0351 does not specify frequency of inspections associated with fire barriers (i.e., ceilings, walls, floors). Ten-year interval appears too long for the fire barriers. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Include fire break (fire stop), fire wraps, and concrete grout in the scope of program. Add essential information regarding the IEEE-383 test method to measure the flame resistance of wire and cable products.
2. Preventive Actions	UFSAR Section 9.5.1, Appendices 9.5.1A, 9.5.1B & 9.5.1C describes plant fire protection features in the format of Appendix A to Branch Technical Position APCSP 9.5-1, and addresses requirements for 10 CFR 50, Appendix R relative to safe shutdown.	No action items for SLR-GD revisions.
3. Parameters Monitored/	The Parameters Monitored/Inspected are: • Loss of material due to general corrosion	RNP does not specify which components have these aging mechanism/aging effects:

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Inspected	• Cracking due to differential movement • Cracking due to vibration • Delamination and separation due to differential movement • Delamination and separation due to vibration • Loss of material due to abrasion • Cracking due to elevated temperature • Change in material properties due to elevated temperatures As a result of the license renewal review, the program element *Parameters Monitored/Inspected* will be enhanced to note that concrete surface inspections performed under administrative controls for structures monitoring are credited by the Fire Protection Program for inspections of fire barrier walls, ceilings, and floors. Fire doors are inspected every 6 months for signs of damage and holes in doorframe, sill to door clearance, holes and bending of door panel. Material and functional condition of fire doors is also routinely monitored during general area operator rounds, as well as during systems and structures monitoring walkdowns Fire dampers are visually inspected every 18 months for signs of damage and obstructions preventing the damper from closing. Motor Driven Fire Water Pump and Engine Driven Fire Water Pump Tests are performed weekly to verify operability of the pumps. Functional testing of the engine driven fire pump serves to regularly verify the integrity of the fuel oil tank, as well as detect fouling or corrosion of the fuel line, prior to loss of intended function. CO_2 Fire Suppression and Halon Fire Suppression Systems are visually inspected for piping, hoses, and nozzles, semi-annually verifying the weight and pressure	• Delamination and separation due to differential movement • Delamination and separation due to vibration RNP engineers explained that these two items are associated to elastomer seal material in the fire barrier penetrations. They suggested looking at OST-623, since these two items are not in GALL. Bases on RNP's response, the reviewer recommends that these two items may be considered to be added to GALL. Since the discussion for AMPs XI.M26 and XI.M27 were joined, we asked if they had observed degradation of Victaulic joints and evidence of tuberculation as the NMP fire engineers had. They said no evidence of these phenomena at RNP. Verify the inspection results of the fire doors in last 5 years to justify the semi-annual inspection frequency. Verify the recent inspection results of fire dampers. The RNP motor driven fire water pump and engine driven fire water Pump Test are performed weekly to verify operability of the pumps and to verify the integrity of the fuel oil tank, as well as detect fouling or corrosion of the fuel line, prior to loss of intended function In response to our queries if RNP measured the amount of bacterial activity in the fuel (may be done under the Fuel Oil Chemistry Program, we were told that this had been done for 2 years on a quarterly basis, per OST-23 and passed each time. No inspections identified there had been MIC. Special biocides are used for fuel oil addition. It is recommended including the function test of firewater pump in GALL. The RNP Fire Protection AMP includes both motor-driven and diesel-driven fire pump performance testing that is not included in GALL, Rev. 2. RNP fire engineers believed the

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	of each high-pressure cylinder (plant procedure FP-013). Once every 18 months, 10% of each type fire barrier penetration seal in fire barriers is visually inspected. If abnormal degradations (rendering the seal inoperable) are found, a visual inspection of an additional 10% of that seal type shall be performed.	fire pump performance test is needed to be included in the AMP, because the test ensures no degradation of the fuel line. The function test of firewater pump had been in in GALL Rev 0, but then was removed. There was strong sentiment that this should be added to XI.M26 for SLR-GDs. **ACTION ITEM for Consideration for writing SLR-GDs**: Expand materials and aging effects requiring management (AERM) AMR line items; at Ginna, a significant number of those (e.g., fire stops and fire wraps) were not included in GALL 2001 or GALL 2010. See M25.3-1 for details
4. Detection of Aging Effects	Fire barriers penetrations are subject to inspection under the Fire Protection Program. The Fire Protection Program currently provides inspection criteria for fire barrier penetrations and includes inspection criteria for concrete that address cracking, holes, voids, or gaps. In addition, the Structures Monitoring Program administrative controls will be enhanced to note that concrete structure inspections are credited in the Fire Protection Program for inspecting fire barrier walls, ceilings, and floors. (LRA Table 3.3-1, line item 25). Detailed inspections of fire door are conducted semiannually under OST-625. This OST checks material condition of the door and frame, checks clearances, functionally tests latches and hinges, and inspects seals. Additional inspections/functional checks of fire doors are accomplished during operator rounds, systems/structures monitoring walkdowns, as well as normal access/egress. Plant procedures require initiation of trouble tickets/condition reports as applicable. Performance of the engine driven fire pump is accomplished weekly under OST-603, and annually under OST-646. Both evolutions closely monitor engine/pump	1. The RNP Quick Hit Self-Assessment performed on November 26-28, 2012 states that: Fire Protection and Fire Water Programs The programs were reviewed and determined to meet the commitment requirements. However, the existing program owner, who has only had the program for a relatively short period, is leaving RNP before the end of the year. Two other engineers have been selected to assume responsibility for the license renewal aging management programs, but these engineers are unfamiliar with the commitments. It is recommended that these new engineers be given the opportunity to assimilate as much information as possible prior to the January 2013 NRC audit. Additionally, it is recommended that several internal and industry OE events be added to the commitment binder, *e.g.* the dissimilar metal galvanic corrosion related failure at RNP in 2010 and the 2011 Monticello fire water AMP OE (Complete 11/29/12). The write-up lists 2 examples: RNL 2010 and Monticello fire water OE – 2011. There was a section in Commitment binder #12 for OE, but references were removed. We were later sent the information on

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	performance, specifically monitoring and recording pump discharge pressure, verifying engine rpms, oil pressure, coolant temperature, etc. Any abnormal operation of the engine/pump assembly would readily be identified and subject to troubleshooting.	Monticello OE. Verify these commitments. Verify the OE dissimilar metal galvanic corrosion related failure events (RNP in 2010 and the 2011 Monticello fire water AMP) mentioned in the Self-Assessment. GALL Fire Protection System AMR table does not contain galvanic corrosion due to dissimilar metal. It is recommended to include galvanic corrosion in GALL. This is part of Fire Water Systems AMP. 2. General Observation: The RNP quick hit self-assessment was performed as required by EGR-NGGC-0514, License Renewal Implementation Procedure, which requires the following: 9.1.4 Perform periodic assessments of LR commitments and aging management activities at least once every three years. These assessments shall meet the following requirements: Review credited preventive maintenance activities to ensure they are being performed and meet the requirements of LR commitments and aging management programs. Review credited procedures to verify they accurately reflect commitments and aging management programs. Review EGR-NGGC-0512 and Program Implementation Plans in PassPort to verify they accurately reflect the status of LR commitment and aging management program implementation. Determine the overall status of committed actions. Review and incorporate applicable operating experience into the implementation of the assigned aging management program or commitment. RNP is currently over 2 years into the period of extended

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		operation, and 3 years from the last self-assessment (AR 363854). Another driver for this quick hit self-assessment is an upcoming NRC audit of license renewal related aging management programs. Due to resource limitations, this quick hit self-assessment reviewed only a sample of the aging management programs, selecting those AMPs based on the prioritization list provided by the NRC audit team. The following AMPs were reviewed, and their program owners interviewed: Nickel Alloy Nozzles and Penetrations Fire Protection and Fire Water Programs Dam Inspection Program Steam Generator Tube Integrity Bus Duct Aging Management Program Fatigue Monitoring Program Open Cycle Cooling Water Program Preventive Maintenance Program Boric Acid Corrosion Program Flow Accelerated Corrosion Program Reactor Vessel Internals Program The quick hit self-assessment did not review other AMPs that may be germane to the FP/FW programs, namely, fuel oil chemistry program, buried/underground piping/above ground piping tanks programs. Even though not all AMP programs were covered in the quick self-assessment, the RNP periodic self-assessment of AMP (i.e., every three years) is a good practice, and is recommended to all applicants. The fleet participant representing the Progress legacy side noted the LR self-assessment is implemented every three years. We discussed maybe considering this with regulatory aspects **ACTION ITEM for Consideration for writing SLR-GDs**

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		(as result of audit): Expand the program element to include NFPA 805 in the NRC-approved fire protection program (e.g., Technical Requirements Manual, Appendix R program) and provide guidelines in the AMP based on NFPA 805 and RGs related to NFPA 805, such as the following: RG 1.205, Rev. 1, "Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants," Dec. 2009. RG 1.189 "Fire Protection for Nuclear Power Plants," October 2009. Fire protection based on NFPA 805 may have significant impacts on inspection scope and inspection frequencies of the fire protection aging management. See M25.4-1 for details
5. Monitoring and Trending	FP-013 identifies testing/monitoring requirements for the Halon /CO_2 fire suppression systems as being required to support system operability. Additionally, the corrective action program ensures that recurring and/or common mode problems are resolved.	RNP performs trending on two items, pressure of fire pump performance test and number of CR of fire detection systems. RNP engineer took an action item to provide trending results of these two items after the session. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): The GALL program element should emphasize importance of trending, and recommend preparing a trending report on a quarterly basis. See M25.5-1 for details
6. Acceptance Criteria	FP-013 requires inspection of 10% of each type of fire barrier penetration seal every 18 months. Inspection parameters and acceptance criteria are based on design considerations of the type of seal being inspected, and include cracking, shrinkage and separation as applicable.	In response to NRC concern that all in-scope fire coating (whether sprayed-on, painted-on, or wrapped around) is inspected by this procedure (or a similar sister procedure), RNP fire engineer said there was no OE on fire coating. They noted that a major issue was access to qualified and

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Likewise, acceptance criteria are specified which ensure the integrity and functionality of fire doors and dampers. Acceptance criteria for walls, ceilings, and floors are incorporated into TMM-104 and EGR-NGGC-0351, and are adequate to ensure the integrity of these structures. Inspection of Pyrocrete firewalls is addressed by OST-623. This includes inspection of "Fire Protection Sprayed on Coating" (Intumastic 285). Performance testing verifies that corrosion has not fouled fuel supply lines. Any performance deficiencies would result in investigation/root cause analysis as needed to ensure operability and common mode implications are addressed.	certified personnel. **No action items** for consideration for SLR-GD revisions.
7. Corrective Actions	Per Section 15.0 of the Corporate QA Manual, design activities associated with fire protection related items shall be prepared, approved, accomplished and documented in accordance with procedural requirements of the Corporate Appendix B Quality Assurance Program.	No significant issue or further review item was identified. **No action items** for consideration for SLR-GD revisions.
8. Confirmation Process	See above	N/A – this is boilerplate and items of concern are not expected for this element. **No action items** for consideration for SLR-GD revisions.
9. Administrative Controls	See above	The score is 0 (red) for the following indicator: Percentage of impairments that are returned to service within the administrative requirements of FPP-013, 0PLP-01.2, FPP or FP-012 as applicable. NCRs are written for fire protection components not being returned to service within the allowed time limit given in FP-012. During the 3Q-2012, two nuclear condition reports were issued for exceeding the out-of-service time limit for impairments as detailed in FP-012. FD-41 limit switch (547937) and FDR-17 sticking latch (551416) exceeded the 7-day out-of-service time limit. In total there were 11

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		impairments for the period with 2 exceeding the administrative requirement. **<u>No action items</u>** for consideration for SLR-GD revisions.
10. Operating Experience	The last five years of self-assessment and external (triennial) inspections noted a number of strengths and weaknesses, but generally found that the fire protection program was effective in fulfilling regulatory requirements and supporting the operation of RNP. Additionally, a 1996 NRC inspection of the Fire Protection Program was performed. In general, the self-assessments, external inspections, and NRC Inspection reports provide evidence that the fire protection program is not only effective, but also subject to ongoing observation/assessment and continual improvement. Plant operating experience includes general corrosion related failure of the fire pumps in the splash zones of the pump casings. This aging effect is managed by periodic replacement of the pump casings under the site PM program. Note that the pump casing is considered part of the Fire Water System, and aging effects directly associated with this component are managed by the Fire Water System Aging Management Program.	1. NRC IN 88-56, IN 94-28, and IN 97-70 provide OE related to degradation of silicone foam fire barrier penetration seals. NRC IN 91-47 and GL 92-08 provide OE of degradation of electrical raceway fire barrier, and fire doors experienced wear of the hinges and handles. Verify whether these OEs have been considered in the ongoing observation/assessment and continual improvement. RNP engineers said they will look their AMP to see how these INs are considered in their AMP. The information contained in the RNP Portal lacks of recent CRs on inspections of fire door, fire damper, CO_2 and halon system, fire barriers (fire wall/ceiling/floor), fire wraps and fire resistance coating, penetration seals. RNP engineer has an action item for provide these CRs later. (They are included as part 4 of this worksheet) 2. Investigate the root causes of the CRs and whether they are aging related. When discussed, the RNP participants said they thought this was due to aging of active components. 3. RNP Fire-Protection 2012 Self-Assessment Report identified the following deficiency: **(D2, CR-532430)**, **Diesel Driven Fire Pump performance indicates emergent recurrence of an adverse trend.** An adverse trend identified for the diesel driven fire pump based on ~14 CR's (6 based on low coolant level) between October 2010 and September 2011 provided corrective actions under CR-490939, noted as complete in October 2011. However, the Diesel Driven Fire Pump has experienced low coolant level on two occasions since February 2012. (6 of 14 CRs shared coolant system issues.

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		The remaining 8 did not share a common issue (i.e., failure to start, foundation, oil leak, tachometer, thermostat, run-hour meter, block heater, etc.). Plant system performance expectations indicate corrective action for the adverse trend has not been effective. Investigate these CRs whether they are aging related. When discussed, the RNP participants said they thought this was due to aging of active components 4. Below is from Q3 2012 FP System Health Report (7/1/2012 - 9/30/2012) The Fire Protection Systems are aging with obsolescence, becoming more and more of an issue, so it is difficult to obtain the appropriate replacement parts. This results in more Material Engineering Equivalency Evaluations and subsequent resource demands on support organizations (e.g., Materials and Procurement). Equipment deficiencies continue to be identified over the course of each workweek. The associated long-term asset management (LTAM) plans are in fledgling stages, and it will be years before even a small portion are completed. The detection system continues to display "nuisance" alarms. The high number of emergent equipment issues makes it difficult to maintain overall monitoring of system performance and long-term planning. SA 508608 identified negative trends within the fire protection systems (detection & emergency diesel fire pump) that had been previously identified with LTAM plans. LTAM 11-0396 was initiated to study and implement an upgrade to the site Fire Detection System. LTAM 11-0303 concerns the replacement of the Grinnell Model A-4 sprinkler system valves FP-411 and FP-412 (System 6175). The valves are obsolete and replacement parts are very difficult to get. NCR-532431 Fire Detection System performance indicates

Program Element	Element of Licensee's AMP (LRA Section B.3.1)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		a continued adverse trend based on the number of ARs generated against System 6180. The initial investigation has been completed. The long-term fix is the replacement of the system under LTAM 11-0396. In discussion, they mentioned that the LTAM plan is tied in to detection system. Fleet is well aware of these issues. They thought that maybe some active systems need more consideration for SLR, since fire detection system is not considered passive and long-lived. The LTAM plan is looking at cables under electrical. Considering plant health process, panel wiring, mitigating actions. 5. RNP plant operating experience indicates failure of the fire pumps casings due to general corrosion. It is recommended to include fire pumps in the GALL. Pumps are submerged in lake, so it is outside corrosion – they are overhauled every 10 years. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): EPU could have significant impacts on various auxiliary systems (e.g., adding additional safety equipment to account for the effects of increased decay heat, due to power upgrade). EPU may affect the plant fire protection systems. The GALL Report may request the applicant to address the effects of power upgrade on aging management of the fire protection systems in OE.

B.14.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

The fire detection system has many CRs. Recent assessment on fire detection system performance indicates a continued adverse trend. During the audit, RNP engineer stated that the RNP FP AMP does not include the fire detection systems because most components in the system are active electronic components. Note that NMP-1 also has many CRs on fire detection system including poor reliability of fire panels, detection systems and Drazetz recorder. (See table below summarizing CRs)

FACILITY	TAG	AR_NBR	TYPE	DUEDT	ORIGDT	STATUS	STATDT	SUBJECT
RNP	FDR-1	283253	NCR	20081214	20080614	COMPLETE	20080707	FIRE DOOR 1 FAILED TO LATCH
RNP	FDR-1	323771	NCR	20090916	20090307	COMPLETE	20090310	UNPLANNED INOPERABILITY OF FDR-1
RNP	FDR-13	131057	NCR	20050519	20040702	COMPLETE	20050519	R-FP-04-01 WEAKNESS 2
RNP	FDR-13	431403	NCR	20111103	20101103	COMPLETE	20110302	FDR-13 REQUIRES AN ADDITIONAL HANDLE TO ALLOW CLOSING WHILE
RNP	FDR-15	289610	NCR	20081231	20080730	COMPLETE	20080828	FIRE DOOR 15B OUT OF SERVICE
RNP	FDR-16	401144	NCR	20101231	20100524	COMPLETE	20100617	FIRE DOOR BLOCKED OPEN CAUSING AN UNEXPECTED ALARM IN THE CR
RNP	FDR-17	319503	NCR	20090331	20090213	COMPLETE	20090310	FDR-17, HAGAN ROOM TO CONTROL ROOM DECLARED OOS
RNP	FDR-17	391351	NCR	20101231	20100405	COMPLETE	20100504	FD-17 OUT OF SERVICE TIME EXCEEDED
RNP	FDR-17	550336	NCR	20130719	20120719	COMPLETE	20121010	FIRE DOOR 17 LATCH IS STICKING
RNP	FDR-18	169852	NCR	20051231	20050919	COMPLETE	20070111	FIRE DOOR - PLANNED IMPAIRMENT DUE TO HVS-1 SHUTDOWN
RNP	FDR-18	402084	NCR	20101231	20100529	COMPLETE	20100607	FIRE DOORS 2, 3, AND 18 OUT OF SERVICE TIME EXCEEDED
RNP	FDR-2	290373	NCR	20090205	20080805	COMPLETE	20080828	FIRE DOOR 2 OUT OF SERVICE
RNP	FDR-2	402084	NCR	20101231	20100529	COMPLETE	20100607	FIRE DOORS 2, 3, AND 18 OUT OF SERVICE TIME EXCEEDED

On the issue of low coolant level on diesel fire pump addressed in CAP-NGGC-0201-7-17. Diesel Driven Fire Pump has experienced low coolant level on two occasions since Feb 2012. In the audit, RNP engineer explained the causes were due to pump seal leakage and malfunction of thermal state. The low coolant level on diesel fire pump is not aging related.

Other topics noted in the audit session include.

1. The review noted that the gap analysis between the GALL and the RNP Fire Protection/Fire Water AMP has not been performed yet.
2. No MIC problems in the diesel-driven fire pump fuel line.
3. Inspection of fire barriers includes all fire barriers (e.g., fire wrap and spread fire resistance coating).
4. New NRC requirements as a result of the Fukushima event may have some degree impact on RNP fire protection, such as adding more equipment.
5. RNP is in the transition to NFPA 805. The reviewers are interested to know is there any impact of NFPA 805 on fire protection/fire water AMP, particularly any relaxations on the inspection frequency. RNP will provide follow-up information on this aspect.

6. Inaccessibility of penetrations and fire dampers could make the inspection results inconclusive and/or not finding aging

Overall, the RNP FP AMP is comprehensive and responsible engineers are knowledgeable of the AMP. The AMP contains many procedures for various systems, equipment, and components in the fire protection systems. RNP performs periodic quick hit self-assessment of AMP (i.e., every three years), including fire protection and fire water systems; this is a good practice and is recommended to all applicants.

1. CAP-NGGC-0201-7-17 under D-2 "Fire Suppression System Reliability" "Diesel Driven Fire Pump has experienced low coolant level on two occasions since Feb 2012" – Were these two occasions related to leaks resulting from loss-of-material issues (e.g., corrosion)? Fire engineer in the audit session noted that this was not related to leakage, it was boiling off coolant due to a thermostat issue. Cummins diesel truck engine water pump seal degraded. No issues with coolant since that time.

2. Sheet 2 of 2 "Formal Self-Assessment Report" R-3: (AR-508608-12) – "to utilize the Fire Wrap checkbox for cables…" How does RNP inspect the fire wrap (assuming these are the in-scope SSCs?) Fire engineer in the audit session noted that this was around motor leads and component cooling, mentioned OST-648. Inspection is done by 3rd-party vendor.

3. CP&L RNP-L/LR-0612 for Aging Management Program Fire Protection Program – this procedure appears to be pretty comprehensive in terms of covering various aspects of FP AMP, couple thoughts (recap from previously stated questions):

   (a) P. 12 3-4 Parameter Monitored/Inspected – the routine diesel driven fire pump performance tests (e.g., flow/discharge tests) are capable of verify the fuel line is capable of supplying fuel to the diesel engine. They are not necessarily capable of detecting gradual thinning of the line due to loss of material (e.g. from corrosion if there is bacterial activity in the fuel system). Ask RNP if this is picked up by the Fuel Oil Chemistry AMP (or any of the aboveground/buried piping inspection programs.)

   (b) P. 15 4-2 Detection of Aging Effects – OST-623 directs the inspection of pyrocrete. Is there another procedure that directs the inspection of other fire resistant coating/wrap/spray-on/painted on material? The inspection criteria need to be laid out in one of the procedures.

   (c) Page 23 – section 6.3 Plant OE – this procedure was approved in 2004. Are there any more recent OE examples since 2004 that can be listed here? One of the examples listed here (e.g., the splash zones of the pump casings) appears to be more germane to the Fire Water System. Fire engineer in the audit session noted that these were the submerged ones, thinning of wall (low head) in pump wall – not erosion or cavitation.

B.14.5. Documents Reviewed during the Audit

1. AR 363854
2. AR 365673-09
3. AR-508608-12

4. CAP-NGGC-0201-7-17, Fire Protection Program Self-Assessment 2012, April, 2012.
5. CAP-NGGC-0201-5-18, LR Self-Assessment 2012, Nov. 2012.
6. CR 422782
7. CR-490939
8. CR-532430
9. CR-532431
10. EGR-NGGC-0351, Rev. 18, Conditions Monitoring of Structures.
11. EGR-NGGC-0512, Rev. 6, License Renewal Aging Management Activities.
12. FP-013, Rev. 10, Fire Protection System Surveillance Requirements.
13. GL 92-08
14. IEEE-383
15. IN 88-56
16. IN 91-47
17. IN 94-28
18. IN 97-70
19. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
20. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
21. LTAM 11-0303
22. LTAM 11-0396
23. NFPA 805
24. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
25. NUREG-1801, Rev. 0, Generic Aging Lessons Learned (GALL) Report, April 2001.
26. NUREG-1801, Rev. 1, Generic Aging Lessons Learned (GALL) Report, December 2010.
27. OST-23
28. OST-603, Rev. 33, Motor Driven Fire Water Pump and Engine Driven Fire Water Pump Test (Weekly).
29. OST-623
30. OST-624, Rev. 32, Fire Dampers Inspection (18-month).
31. OST-625, Rev. 32, Fire Doors Inspection (Semi-Annually).
32. OST-646, Rev. 28, Fire Suppression Water System Engine Driven Fire Pump Test (Annual).
33. OST-648
34. PPP-109, Rev. 2, Fire Protection System MOV DP Stroke Test.

35. PRR-353128, Procedure Revision Request.
36. Program Health Report, Fire Protection System (7/1/2012 - 9/30/2012), Dec. 3, 2012.
37. RG 1.189, Fire Protection for Nuclear Power Plants, October 2009
38. RG 1.205, Rev. 1, Risk-Informed, Performance-Based Fire Protection for Existing Light-Water Nuclear Power Plants, Dec. 2009
39. RNP-L/LR-0611, Rev. 1, Fire Water System Program
40. RNP-L/LR-0612, Rev. 5, Aging Management Program Fire Protection Program for H.B. Robinson Unit 2.
41. RNP-L/LR-0631, Rev. 0, Fuel Oil Chemistry Program
42. SA 508608
43. TMM-104, System Walkdown Procedure.

B.14.6. Summary

RNP implements GALL Report AMP XI.M26 Fire Protection through its existing AMP B.3.1, “Fire Protection.” The program is based on GALL Rev. 0 (NUREG-1801, Generic Aging Lessons Learned (GALL) Report, April 2001.) The program manages the aging effects applicable for fire barriers (fire barrier walls, ceilings, floors, penetration seals, and fire doors) and nonwater- based fire suppression systems (halon and carbon dioxide).

The program requires periodic visual inspection of fire barrier penetration seals and fire doors, to ensure their function is maintained. The program also includes periodic inspection and test of the halon and carbon dioxide fire suppression systems and the diesel-driven fire pumps. The diesel-driven fire pump inspection requires the fire pump to be periodically tested, to ensure that the fuel supply line can perform the intended function.

The program is consistent with GALL XI.M26 with the following exceptions and enhancements.

Exceptions:

1. Inspection frequency of fire doors: GALL specifies bi-monthly inspections, whereas RNP performs detailed inspections semi-annually, augmented by frequent inspections during operator rounds and additional inspections under system/structural monitoring procedures.

2. Inspection interval of fire barriers: The RNP inspection interval is based on safety significance of fire barriers, not to exceed 10 years, as compared to the refueling frequency specified in GALL.

3. Valve alignment and system status are not formally verified each month. Operator procedures check valve position and system status subsequent to any system realignments, and as needed to support plant operation, and current procedures/practices deemed acceptable for the current license period are considered to be sufficient for the period of extended operation.

4 Visual inspection criteria: Inspection of fire barriers, under systems and structures monitoring procedures, are performed at a level of scrutiny deemed necessary by trained personnel to ensure operability, but are not specifically required on a level of detail commensurate with VT-1 inspections criteria

Enhancements:

Prior to the period of extended operation, the Fire Protection Program will be enhanced to note that concrete surface inspections, performed under structures monitoring procedures, will be credited for inspection of fire barrier walls, ceilings, and floors (i.e., Commitment #12 in LRA). In the audit, the RNP engineer confirmed that Commitment #12 has been implemented.

The following topics were discussed during the audit.

RNP listed the following two items in their FP AMP Parameters Monitored/Inspected program element; however, the components that were affected by these aging effects/mechanism were not specified.

- Delamination and separation due to differential movement
- Delamination and separation due to vibration

During the audit, the RNP engineers explained that these two items are associated to elastomer seal materials in the fire barrier penetrations.

The staff notes that the fire detection system has many CRs. Recent assessment on the fire detection system performance indicated a continued adverse trend. During the audit, the RNP engineer stated that the RNP FP AMP does not include the fire detection system because most components in the fire detection system are active electronic components.

Regarding the issue of low coolant level in the diesel pump on two occasions since Feb. 2012 as addressed in CAP-NGGC-0201-7-17, RNP engineer explained that the causes were due to pump seal leakage and malfunction of thermal state. These causes were not aging related.

Other topics noted in the audit session include.

- MIC problem has not been identified in the RNP diesel-driven fire-pump fuel lines.

- Fire barriers inspection includes all type of fire barriers (e.g., fire wrap and spread fire resistance coating). Visual inspections of fire barriers and penetrations, which include all sealing devices, are documented. Aging effects associated with flamastic sealants and damper actuators were observed and documented. Delamination and separation of elastomer seal materials in the fire barrier penetrations due to differential movement and vibration were observed and documented.

- RNP is in the transition to NFPA 805. The transition will be completed in September 2013. There is interest to know if there is any impact of NFPA 805 on the RNP fire protection/fire water AMP, particularly any relaxations on the inspection frequency.

- New NRC requirements, because of the Fukushima event, may have some impact on the RNP fire protection/fire water AMP such as adding more fire protection/fire water equipment.

- The RNP engineer stated that inaccessibility of fire barrier penetrations and fire dampers could make the inspection results inconclusive. Also, they are not finding aging degradation, and the decision to replace the obsolete dampers is not easy. Some of the dampers are 30 ft. above floor and in radiation areas.

- RNP performs periodic quick hit self-assessment of AMP (i.e., every three years), including fire protection and fire water systems; this is a good practice, and is recommended to all applicants**.**

- The GALL Rev.1 (2005) recommends diesel-driven fire pump should be periodically tested, to ensure that the pump fuel supply line can perform its intended function with no degradation. Degradation of the pump fuel supply line could be detected from the fire pump performance tests (e.g., flow and discharge tests, sequential starting capability tests, and controller function tests). The GALL Rev. 2 (2010), however, no longer includes the fire pump performance test in the FP AMP. Based on the RNP OE, it is suggested to add the diesel fire pump performance test to GALL for subsequent license renewal.

Overall, the RNP FP AMP is comprehensive. The AMP contains many procedures for various systems, equipment, and components in the fire protection systems. The AMP is effective in monitoring loss of material and cracking, via visual inspection and testing of penetration seals, fire barrier walls, ceilings and floors, cable coatings, fire wraps and fire-rated doors, to verify that these components continue to perform their intended functions. RNP performs periodic quick hit self-assessment of AMP (i.e., every three years), including fire protection and fire water systems; this is a good practice and is recommended to all applicants. The AMP also has been effective for fire pumps and fuel supply line for maintaining their intended functions.

B.15 Fire Water System Program (LRA Section B.3.7)

Associated GALL Report AMP: **2001 GALL Report, XI.M27 Fire Water System**

B.15.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The Fire Water System Program manages the aging effects of loss of material and flow blockage due to fouling of Fire Protection System water flow paths. To ensure no significant corrosion, MIC, or biofouling has occurred in the water-based fire protection system, periodic full flow flush testing, system performance testing, and inspections during maintenance are conducted. Also, the system is normally maintained at required operating pressure, and is monitored such that loss of system pressure would be detected, and corrective actions initiated. The program relies on testing of water-based fire protection system piping and components in accordance with applicable NFPA commitments. In addition, this program will be modified to include (1) field service testing of sprinkler heads in accordance with NFPA 25 once prior to, and again 10 years into the period of extended operation, and (2) either full flow testing of portions of fire protection sprinkler systems that are not routinely subject to flow, or inspecting/UT testing of representative portions of fire protection sprinkler systems exposed to water, but not routinely subject to flow. The initial test or inspection would occur prior to the period of extended operation. Results from initial tests or inspections, reflecting 40 years of service, will be used to determine expansion of test/inspection scope and intervals	[NRC asked for the initial baseline test results (make sure "representative samples" were taken during the testing in accordance w/ NFPA 25 (section 2-3.1.2, NFPA 25, 1998**)** ***During interview, RNP stated that treatment was on service water not fire water.*** *During interview, RNP mentioned that all the sprinkler heads were replaced. Engineers stated that since RNP will replace the sprinkler heads after 50 years use, no test needs to be performed. They stated that they had a whole set of contractors working on this – discussed impacts (including any relaxation) of inspection frequency.* b. Ask for the testing results (either from the fuel oil chemistry program or from the open/closed cycle cooling water programs to ensure no MIC. If MIC were detected, ask to see the remedial program to eliminate MIC. Make sure the corrective program (e.g., chlorination) does not have any untended consequences (e.g., excessive biocide treatment may cause wall thinning.) *RNP said they had been testing for bacteria since 2010. They had not seen degradation problems associated with chlorination. 1. There is no MIC or very minor MIC in the fire water piping which use the lake water. Unintended consequences from excessive biocide treatment (e.g., chlorination) causing wall thinning are not an issue. During the period of extended operation, RNP will test representative samples of above ground fire water system*

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		using non-intrusive techniques (e.g., volumetric testing) or internal inspection at a 10-year interval to identify evidence of loss of material due to corrosion. *The RNP Fire Water System Program manages the aging effects of loss of material and flow blockage due to fouling of Fire Protection System water flow paths. Periodic full flow flush testing, system performance testing, and inspections during maintenance are conducted. The program is enhanced to include (1) field service testing of sprinkler heads in accordance with NFPA 25 once prior to, and again 10 years into the period of extended operation, and (2) either full flow testing of portions of fire protection sprinkler systems that are not routinely subject to flow, or inspecting/UT testing of representative portions of fire protection sprinkler systems exposed to water, but not routinely subject to flow.* **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Add the following statements for plants using raw water such as lake- or seawater as a water source (as opposed to city water): "For plants using raw water (e.g., lake- or seawater as a water source), the program consists of periodic sampling and analysis of water systems for the presence of bacteria and microbiological contamination."
1. Scope of Program	The aging management program focuses on loss of material due to corrosion, MIC, or biofouling of carbon steel and cast-iron components in fire water systems. Hose station and standpipe are considered as piping in the AMP. The program has an enhancement: • NFPA 25 requires a program of field service testing of sprinkler heads be implemented for those in service for 50 years. The RNP Fire Water System Program will	Fire Protection Program Health Report (RNP Portal doc. #106) States: New NRC requirements as a result of the Fukushima event are projected to have a major impact on Fire Protection. *New NRC requirements as a result of the Fukushima event may have some degree impact on Fire Water System such as adding more equipment to ensure availability of fire water/fire equipment in the seismic event. During interview, RNP stated that Sarah Thompson wrote this as part of*

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	include requirements for an initial test effort implemented prior to the end of the current license period, and repeated 10 years into the period of extended operation.	*long-term asset management, addresses possible seismic issues and repiping service water headers.* Discuss what the impacts are to Fire Protection and Fire Water Programs. RNP is also in the transition to NFPA 805, discuss what the impacts are of NFPA 805 to Fire Protection and Fire Water Programs. *RNP engineer recommended including galvanic corrosion in GALL fire water system. RNP is in the transition to NFPA 805. The reviewers are interested to know is there any impact of NFPA 805 on fire protection/fire water AMP, particularly any relaxations on the inspection frequency. RNP will provide follow-up information on this aspect. They subsequently provided documents referenced at the end of this worksheet.* **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Add guidance on aging management of fire water systems that are made of other materials (e.g., brass, cement, or PVC) and the normally dry portions of the fire water system (e.g., yard nozzle and dry piping).
2. Preventive Actions	Specific surveillance activities include testing under OST-602 (valves), OST-603, OST-622 & OST- 646 (pumps, weekly and annually) OST-609, OST 632, OST-641 & OST-647 (flushing / flow paths), OST- 610 & 687 (hose stations)	No significant issue or further review item was identified. **<u>No action items</u>** for consideration for SLR-GD revisions.
3. Parameters Monitored/ Inspected	Parameters Monitored/ Inspected include: • Flow Blockage due to Fouling • Loss of Material due to Crevice Corrosion • Loss of Material due to Galvanic Corrosion • Loss of Material due to General Corrosion • Loss of Material due to MIC • Loss of Material due to Pitting Corrosion The system's ability to maintain pressure is continuously monitored. Any significant increase in system demand	1. Verify the results of the full flow test or the results of internal inspections or UT which were conducted prior to the period of extended operation and what are subsequent test/inspection intervals based on the results from the initial tests and inspections which reflect 40 yrs of service. 2. The RNP fire water systems use lake water. For plants using raw water (e.g., lake- or seawater as a water source), the AMP program usually consists of periodic sampling and analysis of water systems for the presence of bacteria and

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	(including leakage) will result in a drop in system pressure, and automatic start of the Motor Driven Fire Pump, resulting in Control Room indication and alarms. Additionally, internal system conditions are monitored through visual inspections when system components are opened for maintenance. Periodic full flow flushing of system piping / loops is accomplished under OST- 609 (Interior buildings), OST-632 (main loops), OST-641 (Containment) & OST- 647 (outside) Prior to the period of extended operation, flow testing of fire protection wet pipe sprinkler systems will be conducted through the systems' cross mains, which are not routinely subject to flow, at the greatest flow and pressure allowed by the design of the systems. Or, as an alternative, internal inspections or UT examinations will be conducted on a representative sampling of these systems. Results from initial tests and inspections, reflecting 40 years of service, will be used to determine expansion of scope and subsequent test/inspection intervals, not to exceed 10 years. OST-610 Unit 2 Portable Fire Extinguishers, Fire Hose Stations and Houses (Monthly): Check for physical defects to hoses or other equipment. Any equipment, which is missing or has poor material condition, should be replaced as soon as practical.	microbiological contamination. industry personnel were asked if RNP Fire Water Program perform periodic sampling and analysis of water systems for the presence of bacteria and microbiological contamination. *The RNP fire water systems use lake water. The AMP consists of periodic sampling and analysis of water systems for the presence of bacteria and microbiological contamination. RNP will provide the recent sampling results of the lake water. They subsequently submitted documents noting that bacterial limit tests had been consistently successfully passed in the 9 tests conducted between March 2011 and December 2012.* NRC noted that if microbiological contamination is detected, make sure RNP's corrective action (e.g., shock treatment with chlorination compounds) does not have unintended consequences (e.g., excessive chlorination corrodes copper alloy in the system, which exacerbate other corrosion problems) **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Consider adding reference to periodic sampling and analysis of water systems for the presence of bacteria and microbiological contamination.
4. Detection of Aging Effects	Before exceeding the current license term, ultrasonic inspection on a representative sampling of the above ground fire protection suppression piping normally containing water will be performed. Each sampling will include different sections of piping. An alternative method is to conduct internal inspections on a representative sampling of these piping systems.	1. Note that in GALL 2, the maintenance process may include a visual inspection of the internal surface of the fire protection piping upon each entry to the system, for routine or corrective maintenance, as long as it can be demonstrated that inspections are performed (based on past maintenance history) on a representative number of locations on a reasonable basis.

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	The interior surface of the below grade fire protection piping is sufficiently similar to the conditions that exist within the above grade fire protection piping, such that the results of the inspections of the above grade fire protection piping can be extrapolated, to evaluate the condition of below grade fire protection piping. Fire hose stations and hydrant hose houses are inspected monthly. Yard hydrants are inspected annually, including hydrostatic hose testing, gasket inspections, flow testing /flushing. Sprinkler systems are inspected each refueling, as a minimum as required by FP-013. Additionally, System walkdowns are regularly performed under the Systems Monitoring Program. The FP-013 "Fire Protection Systems Surveillance Requirements" requires that the Fire Suppression Water Supply System shall be demonstrated operable: 1. Weekly by starting the diesel engine driven fire pump from ambient conditions and operating it for at least 30 minutes. 2. Weekly by starting the electric motor driven fire pump from ambient conditions and operating it for at least 10 minutes. 3. Monthly by verifying that each isolation-valve (manual or motor operated) in the firewater distribution piping flow path to the suppression systems. 4. Annually by cycling each isolation valve in the firewater distribution piping flow path to the suppression systems through at least one complete cycle of full travel, except for the fire water system valves in containment, which shall be cycled every refueling. 5. Annually by performing a pump flow test, which	The RNP AMP was developed using GALL Rev. 0. Industry personnel were asked if the RNP AMP should be updated to reflect the changes in GALL Rev. 2. *The RNP engineers have kept the fire water system program dynamic, in response to RNP and industry OE; they have not done a formal reconciliation with GALL Rev.2.* 2. The ground water of RNP is aggressive (low pH value). Industry personnel were asked about any degradation of the buried or underground fire water systems. *The RNP fire water piping did not have the issue of formation of tubercles, which has been found in the Ginna fire water piping.* *The RNP fire water system still uses Victaulic coupling (as at NMP-1), and is looking at wholesale mitigation. NMP-1 engineers believe that the life of Victaulic joints may be the major issue of the fire water system for subsequent license renewal. Currently in NUREG-1801, Rev. 2, only 5 out of 1,520 AMR line items are based on XI.M27. Based on operating with tuberculation and Victaulic seals, these may need more attention.* **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Consider adding Victaulic joints as a material of consideration. Add the sentence "Periodic sampling and analysis of the raw-water-based fire protection systems is performed to check for the presence of bacteria and microbiological contamination."

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	includes simulated automatic actuation of the pump throughout its operating sequence, and: (a) Verifying that each pump develops at least 2500 gpm at a system pressure of 125 psig. (b) Verifying that each fire pump starts sequentially from ambient conditions to restore the fire suppression water supply pressure to 125 psig while loaded with the fire pump. The Fire Suppression Water Supply System shall be inspected as follows: 1. Before exceeding the initial 40 year license term, inspect a representative sampling of different sections of the above ground fire protection piping normally containing water by one of the following methods: - Ultrasonic test methods, - Other industry accepted method, or - Internal inspections 2. On an interval NOT to exceed 10 years, subsequent tests OR inspections shall be performed. Results from the initial test or inspection, reflecting operation during the first licensing term, will be used to determine expansion of scope and subsequent test/inspection intervals.	
5. Monitoring and Trending	System pressure is monitored and trended as required by NFPA codes and standards.	The RNP portal does not contain CRs. Verify the CRs during the audit. Verify trending of CRs, occurrence frequency of similar CRs. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): The GALL program element states, "Degradation identified by non-intrusive or visual inspection is evaluated." Change the statement to "Degradation identified by non-intrusive or visual inspection is evaluated <u>and trended</u>." The following statement should also be added: "An appropriate means of recording, evaluating, reviewing, and trending the results of visual inspections and

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		volumetric testing is established before period of extended operation." This is a good practice, and is recommended for all the AMPs generically.
6. Acceptance Criteria	NFPA 25 states that sprinklers in place for more than 50 years shall be replaced, or representative samples shall be subject to field service testing. It also contains guidance to continue sampling every 10 years after the initial field service testing. The nozzles will be replaced or a program of sampling/field service testing will be implemented, per the NFPA 25 requirements, based on the commissioning date of the affected systems.	No significant issue or further review item was identified.
7. Corrective Actions	Per Section 15 of the Corporate QA Manual, design activities associated with fire protection related items shall be prepared, approved, accomplished and documented, in accordance with procedural requirements of the Corporate Appendix B Quality Assurance Program. Additionally, the Corporate Quality Assurance Manual states that activities associated with design, installation, inspection, tests, maintenance and modification of fire protection related systems shall be accomplished, in accordance with procedures and drawings controlled in accordance with the Corporate Appendix B Quality Assurance Program.	No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.

Program Element	Element of Licensee's AMP (LRA Section B.3.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
10. Operating Experience	Plant operating experience documents corrosion-related failure of the fire pump casings, due to general corrosion and thinning in the "splash zones". This aging mechanism is managed by replacing the pump casings periodically, in accordance with the plant PM program. No pump casing failures have been documented since the implementation of this program. The last five years of self-assessment and external (triennial) inspections were reviewed for programmatic deficiencies that remained outstanding. These inspection reports noted a number of strengths and weaknesses, but generally found that the fire protection program was effective in fulfilling regulatory requirements and supporting the operation of RNP. The Program Health Report (7/1/2012 – 9/30/2012) revealed that the Overall Health of the Fire Protection Program is Yellow (score 77.09). The Trend of the Program Health remains the same as last quarter with a decline over the last 4 quarters.	*Plant operating experience indicates failure of the fire pump casings, due to wall thinning in the "splash zones". The RNP engineer confirmed that wall thinning at the splash zones is due to general corrosion, not from erosion. This aging mechanism is managed by replacing the pump casings every 10 years by the plant PM program. No pump casing failures have been documented since the implementation of this program. It is recommended including the aging effect of wall thinning in the "splash zones" of fire pump casing, due to general corrosion, as a line item in the GALL.* *The most recent self-assessment was conducted on Nov. 26-28, 2012 (Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, FORM CAP-NGGC-0201-5-18), and recommended that several internal and industry OE events be added to the commitment binder, e.g. the dissimilar metal galvanic corrosion related failure at RNP in 2010 and the 2011 Monticello fire water AMP OE. These were provided to NRC reviewer following the interview.* **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Based on OE with tuberculation and Victaulic seals, these items may need additional focus. Include the RNP and Monticello OE related to loss of material due to dissimilar metal galvanic corrosion

B.15.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.15.5. Documents Reviewed during the Audit

1. CAP-NGGC-0201-5-18, Rev. 18, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, Nov. 26–28, 2012.
2. CAP-NGGC-0202-7-20, Review of Monticello (Green Finding) Failure to Follow Fire Water Aging Management Program Implementing Procedure, Dec. 29, 2011.
3. CAP-NGGC-0205-2-12, Fire water piping 2-FP-29 ruptured due to galvanic corrosion (Bruce Gerwe), Oct. 14, 2010.
4. FP-013, Rev. 10, Fire Protection System Surveillance Requirements.
5. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
6. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
7. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
8. OE 27901
9. OMM-002, Preaction Sprinkler System Internal Corrosion and Slime Buildup (Crystal River, written by Bruce Gerwe), Sept. 2011.
10. OST-610, Rev. 56, Unit 2 Portable Fire Extinguishers, Fire Hose Stations and Houses (Monthly).
11. Program Health, (RNP Portal Doc. 106), Fire Protection.
12. Program Health Report, Fire Protection System (7/1/2012 - 9/30/2012), Dec. 3, 2012.
13. RNP-L/LR-0611, Rev. 1, Fire Water System Program
14. Report of Bacterial Analyses at sample point: DIESEL FIRE PUMP FOST - Diesel Driven Fire Pump Fuel Oil Tank, Jan. 9, 2013.
15. WO 01519261, License Renewal Performance OSt-656 & UT CCW, License Renewal Performance UT CCW Sprinkler Piping, May 5, 2012

B.15.6. Summary

RNP implements this program through its AMP B3.7 “Fire Water System.” The program is based on GALL Rev. 0 (NUREG-1801, Generic Aging Lessons Learned (GALL) Report, April 2001.) The program manages the aging effects of loss of material and flow blockage due to fouling of fire water systems. To ensure no significant corrosion, MIC, or biofouling has occurred in the water-based fire protection system, periodic full flow flush testing, system performance testing, and inspections during maintenance are conducted. In addition, the system is normally maintained at required operating pressure and is monitored such that loss of system pressure would be detected and corrective actions initiated. The program relies on testing of the water-based fire protection system piping and components in accordance with applicable NFPA commitments.

The aging effects/mechanisms of concern in this program are:

- Flow Blockage due to Fouling
- Loss of Material due to Crevice Corrosion
- Loss of Material due to Galvanic Corrosion
- Loss of Material due to General Corrosion
- Loss of Material due to MIC
- Loss of Material due to Pitting Corrosion

The program is enhanced to include field service testing of sprinkler heads in accordance with NFPA 25, once prior to, and again 10 years into the period of extended operation. The program has an exception on GALL. The exception is that, in the flow tests portion of the sprinkler system that are not routinely subjected to flow, the program proposed to perform the flow tests in accordance with GALL, or by performing internal inspections or UT examinations of the sprinkler system that are not routinely subjected to flow. RNP's proposed exception is consistent with, "Interim Staff Guidance (ISG)-04: Aging Management of Fire Protection Systems for License Renewal," dated December 3, 2003.

During the audit, RNP engineers explained that the fire water systems use lake water. The AMP performs periodic sampling and analysis of the fire water systems for the presence of bacteria and microbiological contamination. RNP engineers provided documents that indicate bacterial limit tests had been consistently passed in the nine tests conducted between March 2011 and December 2012. The RNP engineers also mentioned that there is no MIC or minor MIC in the firewater piping. Chlorination is used only for service water. Unintended consequences from excessive biocide treatment (e.g., chlorination) causing wall thinning are not an issue for the RNP fire water systems. The RNP engineers further stated that the RNP firewater piping did not have the issue of formation of tubercules, which has been observed in the Ginna firewater piping.

Fire hose stations and hydrant hose houses are inspected monthly for physical defects and missing or poor material condition. Yard hydrants are inspected annually, including hydrostatic hose testing, gasket inspections, and flow testing/flushing. Sprinkler systems are inspected each refueling, as a minimum. All sprinkler heads will be replaced after 50 years use; no test needs to be performed.

The plant procedure FP-013 "Fire Protection Systems Surveillance Requirement" requires the following activities of the RNP fire suppression water supply system to demonstrate its operability:

- Weekly starting the diesel-driven fire pump and operating for at least 30 minutes.

- Weekly starting the electric-motor-driven fire pump and operating it for at least 10 minutes.

- Monthly verifying of each isolation valve in the firewater distribution piping flow path.

- Annually cycling of fire water systems valves through at least one complete cycle of full travel, except for the fire water system valves in containment, which shall be cycled every refueling.

- Annually performing pump flow test to verify each pump develops specified system pressure.

RNP operating experience indicated that failure of the fire pump casings has occurred due to wall thinning in the “splash zones”. The staff was not clear whether the wall thinning was caused by erosion. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): During the audit, RNP engineers explained that wall thinning at the fire pump casing was caused by general corrosion, not erosion, and the plant PM procedure was modified to replace fire pump casing every 10 years. No pump casing failures have been reported since implementation of the PM procedure. It is suggested to incorporate this operating experience in GALL.

As a result of galvanic corrosion conditions noted in FORM CAP-NGGC-0205-2-12, RNP conducted an inspection of pipe unions in the 2” or smaller aluminum fire water piping to avoid a repeat in joining of the aluminum pipe and the bronze fittings without a dielectric insulator between them. This condition has resulted in galvanic corrosion of the RNP aluminum fire-water piping. RNP conducted this inspection in the auxiliary building and fuel handling building, and did observe two other potential precursors to galvanic corrosion, which were taken care of under the plant corrective action program. During the audit, RNP engineers recommended including galvanic corrosion in the GALL fire-water AMP.

Other topics noted in the audit session include:

- The most recent Self-Assessment report of the RNP fire water system conducted on Nov. , 2012 recommended that several internal and industry OE events be added to the commitment binder, including the dissimilar metal galvanic corrosion related failure at RNP in 2010 and the 2011 Monticello fire water AMP OE.

- RNP is in the transition to NFPA 805. The transition will be completed in September 2013. There is interest to know if there is any impact of NFPA 805 on the RNP fire protection/fire water AMP, particularly any relaxations on the inspection frequency.

- New NRC requirements introduced, because of the Fukushima event, may have some degree of impact on the RNP fire protection/fire water AMP such as adding more fire protection/fire water equipment.

Based on review of inspection procedures and discussion with AMP program owners, the AMP is effective in managing the aging effects of loss of material and flow blockage due to fouling of fire water system flow paths. Periodic full flow flush testing, system performance testing, and inspections during maintenance are conducted to ensure no significant corrosion, MIC, or biofouling has occurred in the water-based fire protection system. The last five years of self-assessment and external (triennial) inspections were reviewed during the audit for programmatic deficiencies that remained outstanding. These inspection reports noted a number of strengths and weaknesses, but generally found that the program was effective in fulfilling regulatory requirements and supporting the operation of RNP.

B.16 Reactor Vessel Surveillance Program (LRA Section B.3.11)

Associated GALL Report AMP: **2001 GALL Report, XI.M31 Reactor Vessel Surveillance.**

(Note: There was only a minimal worksheet prepared and no audit report was prepared)

B.16.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.11)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected. If there is an issue, include pertinent text from the program description.	No significant issue or further review item was identified.
1. Scope of Program	The RNP LRA notes that its AMP B.3.11 is consistent with the associated GALL AMP XI.M31, Reactor Vessel Surveillance, with enhancement. The enhancement deals with revising RNP procedures, prior to the start of the PEO, to require surveillance test samples to be stored in lieu of optional disposal. The enhancement to RNP AMP B.3.11 was LR Commitment #22, which has been met and the relevant UFSAR sections updated (per NRC IR 2010008).	No significant issue or further review item was identified.
2. Preventive Actions		No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected		No significant issue or further review item was identified.
4. Detection of Aging Effects	The withdrawal of its Capsule "U" (5th one) was scheduled just after the start of the PEO (in 2012 with 29.8 EFPY, with fluence representative of the 60-year term of the PEO). RNP submitted a change to this withdrawal schedule (ADAMS ML11276A002) postponing it to 38 EFPY. This change has been approved by the NRC	Check/confirm that the UFSAR (Section 5.3.1.6, "Material Surveillance") is consistent with the updated and as-approved changes to the surveillance capsule schedule. The RNP request for change of schedule (ADAMS ML11276A002) also included a plan for repositioning two capsules (Y and W) at the end of 40th calendar year. The

Program Element	Element of Licensee's AMP (LRA Section B.3.11)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	(ADAMS ML11349A026).	Staff's review (ADAMS ML11349A026) noted this repositioning to be consistent with GALL Report, Rev. 2. Check and confirm the status of this repositioning, UFSAR update, and RNP plan for review/approval of these repositioned capsules for long term operation. **No action items** for consideration for SLR-GD
5. Monitoring and Trending		Since the 60-year fluence data (originally from capsule U) will not be available, and the change of schedule to remove the capsule U about 11 years after the start of the PEO, RNP personnel were asked if is there any change in the basis needed or used in the RNP estimation method(s) for the 60-year projected material properties, as well as the projected fluence. The licensee was asked if there any change of frequency with which dosimetry data are monitored and/or how these are trended (projected) during the PEO. **No action items** for consideration for SLR-GD
6. Acceptance Criteria		No significant issue or further review item was identified.
7. Corrective Actions		No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience		No significant issue or further review item was identified.

B.16.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.16.5. Documents Reviewed during the Audit

1. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
2. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
3. RG 1.99, Rev. 2
4. RNP-L/LR-0501, Rev. 1, 2002.
5. RNP-RA/11-0038, Revision to Reactor Vessel Surveillance Capsule Removal Schedule, H.B. Robinson Steam Electric Plant, Unit 2, ADAMS ML11276A002, Sept. 28 2011.
6. RNP Request for Revision to Reactor Vessel Surveillance Capsule Removal Schedule, TAC NO. ME7533, ADAMS ML11349A026, Dec. 21 2011.
7. RNP UFSAR, Rev. 20, Ch. 18.
8. SwRI 02-3574.
9. SwRI 02-4397.
10. WCAP-15805.

B.16.6. Summary

RNP LRA Section B.3.11 summarizes RNP's implementation of the associated GALL AMP XI.M31 – Reactor Vessel Surveillance (Rev. 0 of GALL Report, 2001). The RNP LRA AMP B.3.11 notes, and staff's SER (NUREG-1785) confirms, that the LRA AMP is consistent with the associated GALL Report AMP, with enhancement. The enhancement deals with revising RNP procedures, prior to the start of the PEO, to require surveillance test samples to be stored in lieu of optional disposal. The enhancement was LR Commitment #22, which has been met, and the relevant UFSAR sections updated, as verified by the staff's Post-approval Site Inspection for License Renewal Inspection Report (NRC IR 201008).

RNP credits its Reactor Vessel Surveillance Program for aging management of the reactor vessel upper shell, intermediate shell, and lower shell, as well as the reactor vessel inlet and outlet nozzles, for the aging effect and mechanism of irradiation embrittlement resulting in a change of material properties, due to prolonged neutron exposure. RNP performs the projections of changes in material properties, in accordance with NRC Regulatory Guide 1.99, Rev. 2, using both methods allowed: The neutron embrittlement, using chemistry tables, and using the surveillance data, where credible, for which its program is set up to collect data during remainder of the current operating term, and during the PEO.

As part of the audit, the staff enquired about the status and plans for Surveillance Capsules labeled U, W, Y, and Z at RNP. RNP noted that withdrawal of 'U' was originally planned at about 29.8 EFPY (approximately the start of the PEO, with a lead factor corresponding to about 60 calendar years, or the end of the PEO); this plan was revised postponing the withdrawal at about 38 EFPY (nearly 11 years after the start of the PEO, for lead factor corresponding to 80 calendar years), as approved recently by the staff (ADAMS ML11349A026). RNP noted that its request for change of schedule (ADAMS ML11276A002) also included a plan for repositioning its two capsules (Y and W) at the end of 40th calendar year. The staff's review (ADAMS ML11349A026) noted this repositioning to be consistent with GALL Report, Rev. 2. With regard to Capsules W and Y, RNP also indicated that the two were relocated during its RO27 to higher fluence locations. For Capsule Z, RNP stated that it was withdrawn in 1977 and in store, but has no further plans for it.

The staff also requested results on Capsule V under RNP's surveillance program. RNP noted that 'V' was withdrawn around 1975-1977, and its testing and results were summarized in old SwRI reports [02-3574 and 02-4397]. Additionally, the staff requested the conclusions from the analysis of Capsule X, with regard to adjustment for a period of low temperature operation experienced by this capsule. RNP indicated that the respective documents on these results will be provided on its portal.

The staff asked if there were any changes to plant operation since the RNP license was renewed, which could affect the vessel fluence or embrittlement. RNP indicated there were no changes affecting these aspects of the program. RNP noted that their surveillance program is one of the few programs with availability of capsules suitable for long-term data collection, covering LTO, and that it is actively cooperating with related industry initiatives in this area.

During the audit the staff also enquired if there were any materials, other than those considered in the beltline region of the surveillance program, for which the projected fluence (during the PEO and LTO) may reach or exceed the limit of 10^{17} n/cm^2, such as the vessel nozzle materials. RNP indicated this to be unlikely. The staff noted that any materials-related chemistry factors are reviewed separately under the relevant TLAA programs. In this connection the staff requested RNP to provide for review the latest revision of RNP-L/LR-0501 (re: Neutron Embrittlement TLAA for the RNP Reactor Vessel) and a copy of the basis document WCAP-15805. RNP indicated that these will be provided for staff's review. From Rev. 1 of RNP-L/LR-0501 (dated 2002) the staff noted that RNP's 60-year fluence was projected (calculated) based on surveillance data from its capsules V, S, and T, (a replacement capsule irradiated during its Cycle 9 operation), and its Reactor Cavity Neutron Monitoring Program (from Cycles 9 through 15). The RNP evaluation showed the beltline materials to be more limiting, relative to pressurized thermal shock (PTS) and upper shelf energy (USE), than its inlet/outlet nozzles and associated welds. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): It was not apparent, however, how the capsule data are used

in validation and benchmarking of the projected (calculated) fluence, which suggests an area of improvement in guidance to be specified in the SLR-GDs.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): The AMP implementation at RNP seemed to follow the path consistent with GALL Rev. 2 (AMP XI.M31), and recommendations of the industry guidance, suitable for assessing LTO for adequate management of the RPV embrittlement effects. A consolidated review of RNP's findings from tested capsules, and its planned modifications to capsules relocation, scheduled during the PEO would be useful. The availability of capsules at RNP for longer term dosage, and RNP's program changes to better utilize these, are useful features that also may be more explicitly integrated in providing further guidance via SLR-GDs or Appendix H.

B.17 One-Time Inspection Program (LRA Section B.4.4)

Associated GALL Report AMP: **2001 GALL Report, XI.M32 One-Time Inspection**

B.17.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	This new program is to perform one-time checks to verify that existing and plant specific programs are effective in accomplishing their goal of plant long-term maintenance on specific components or systems. The systems or components are listed in program document L/LR-0632 and the inspections will consist of: SW/CCW heat exchanger tubes; miscellaneous piping such as feedwater, condensate, etc.; small bore RCS piping; diesel generator exhaust silencers; reactor containment moisture barrier; containment liner plate; and diesel fire pump fuel oil tank wall thickness. The applicant has included these future actions in their AMP Implementing Documents database. During the last outage, the applicant had performed some initial heat exchanger tube eddy current inspections, and was planning the other future inspections. The tubes had been replaced in 1990 and had an expected life of at least 20 years. The inspectors discussed the initial results with the system engineer. The inspectors walked down the diesel generator exhaust and found no external problems. The applicant had made some initial attempts at inspecting the interior of the Emergency Diesel Generator silencers, and was working out the details for future effort. The inspections of the containment moisture barrier and liner are scheduled for completion by 2005. The general containment is inspected regularly under ASME IWL.	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
1. Scope of Program	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL with the exceptions that the RNP One-time Inspection Program performs the plant-specific one-time inspections for the following structures/components not identified by GALL: • CV Moisture Barrier and Liner Plate • CCW Heat Exchanger Tubes • Diesel Generator Engine Silencers • Diesel Fire Pump Fuel Oil Tank	Subsequent to license renewal at RNP, GALL Rev. 2 now includes a separate AMP for the one-time inspection of small-bore piping. Industry personnel were asked if changes were made to the present AMP, with respect to the inspection of small-bore piping (e.g., inspection techniques, inspection frequency, and sample sizes), in response to the new GALL Rev. 2 program. As noted in RNP-L/LR-0632, Attachment 5, WCAP-14575-A, Applicant Action Item # 6, requires the license renewal applicant to perform additional inspections of small-bore RCS piping, to provide assurance that potential cracking is adequately managed during the period of extended operation. **No action items** for consideration for SLR-GD revisions.
2. Preventive Actions	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
4. Detection of Aging Effects	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL. According to the RNP "One Time Inspection Program License Renewal Commitment" document, 21 inspections of miscellaneous piping in the steam and power conversion systems were performed in 2004 during RO-22. An additional 12 inspections were completed during RO-26 in 2010. The inspection locations were selected based on material and environments that would represent leading indicators of age-related degradation. In addition, total 131 small-bore piping welds were	The RNP "One Time Inspection Program License Renewal Commitment" document states that for mechanical system inspections, the sample size will be in accordance with code requirements or "otherwise justified." Provide further details on the sampling process and determination of sample size and its consistency with the guidance given in GALL, Rev. 2 AMP XI.M32 Program Element 4. Provide examples of "otherwise justified" sampling processes. **No action items** for consideration for SLR-GD revisions.

Program Element	Element of Licensee's AMP (LRA Section B.4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	determined to be within the scope of the inspection population. Seven UT examinations of small bore piping welds were performed during RO-25 in 2008. An additional 20 examinations were completed during RO-26 in 2010. No adverse conditions were identified.	
5. Monitoring and Trending	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	
6. Acceptance Criteria	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
7. Corrective Actions	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	No significant issue or further review item was identified.
8. Confirmation Process	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that this program element is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") states that the RNP One-time Inspection Program is a new program, which is an extension of the existing programs and quality procedures that have been utilized throughout the lifetime of the plant. This program is consistent with the scope and methods of inspections for other similar structures/components.	RNP-L/LR-0632 ("Aging Management Program, One-Time Inspection Program, Rev. 6") cites two condition reports that are applicable to the scope of this AMP, namely CR 99-02070 (Assessment of Subsections IWE and IWL) and CR 99-02074 (Assessment of plant procedure TMM-124, Inservice IWE/IWL Program). The Industry personnel were asked if they experienced any problems with low-temperature SCC of stainless steel components in stagnant regions of piping systems, similar to that described in IN 2011-04. **No action items** for consideration for SLR-GD revisions.

B.17.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.17.5. Documents Reviewed during the Audit

1. Bulletin 88-09, Status Update for, H. B. Robinson, Serial: RNP-RA/09-0025, ADAMS ML091100397, 4/13/2009.
2. CR 99-02070, Assessment of Subsections IWE and IWL.
3. CR 99-02074, Assessment of plant procedure TMM-124, Inservice IWE/IWL Program.
4. IN 97-46
5. IN 2011-04, Contaminants and Stagnant Conditions Affecting Stress Corrosion Cracking in Stainless Steel Piping Pressurized Water Reactors, 2-23-2011.
6. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
7. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
8. One Time Inspection Program License Renewal Commitment.
9. RNP-L/LR-0632, Rev. 6, Aging Management Program, One-Time Inspection Program, 6-16-2004.
10. WCAP-14575-A

B.17.6. Summary

RNP implements this program through its One-Time Inspection Program (AMP B.4.4). The RNP LRA states that this program was a new program at the time of license renewal and is consistent with GALL, Revision 0, AMP XI, M32 (“One-Time Inspection”). The LRA also states that the program was created to verify the effectiveness of existing AMPs, as well as to provide additional assurance that aging is not occurring or the aging is so insignificant that aging management is not required for the license renewal period. The AMP is credited for managing a variety of aging effects in various systems at RNP, including piping in several systems, diesel generator engine exhaust silencers, and various reactor containment system components.

As a part of the license renewal process, RNP committed to one-time inspections of a number of components. These inspections, and the resulting observations and follow-on activities, as discussed during the audit, are listed below:

- Component cooling water heat exchanger tubing. RNP stated during the audit that the inspection had determined that some corrosion was present, and the Cu heat exchanger tubes in two heat exchangers were proactively replaced with AL-6XN tubes during RO-25 and RO-26, even though the old tubes still had acceptable wall thickness. In addition, Preventive Maintenance (AMP B.3.18) activities have been established to perform eddy current testing for both heat exchangers on a 6-year frequency.

- Miscellaneous piping in steam and power conversion systems protected by the Water Chemistry Program. A total of 21 inspections of miscellaneous piping in the steam and power conversion systems were performed in 2004 during RO-22. An additional 12 inspections were completed during RO-26 in 2010. The inspection locations were selected based on material and environments that would represent leading indicators of age-related degradation.

- The small bore reactor coolant system and connected piping to verify effectiveness of the Water Chemistry Program. Components to be examined will be selected based on accessibility, exposure levels, NDE techniques, and locations identified in NRC IN 97-46. A total of 131 small-bore piping welds were determined to be within the scope of the inspection population. Seven UT examinations of small bore piping welds were performed during RO-25 in 2008. An additional 20 examinations were completed during RO-26 in 2010. No adverse conditions were identified.

- Emergency diesel generator exhaust silencers. The component configuration made a thorough inspection difficult, but preliminary findings indicated corrosion, and the silencers were replaced.

- Certain inaccessible areas of the containment liner plate and containment structure moisture barrier behind insulation panels at the regenerative heat exchanger and refueling canal. Again, access was difficult and dose levels were high, and since the portions of the moisture barrier showed signs of degradation, they were replaced.

- The diesel fire pump fuel oil tank. This inspection was carried out, but the details were not discussed during the audit.

- Steam Generator feed ring/J-nozzles. This inspection was carried out, but the details were not discussed during the audit.

In response to a reviewer's question concerning RNP's operating experience with small-bore piping socket welds, it was stated that there had been no significant cracking problems, either from SCC or fatigue. The RNP personnel also noted the difficulties associated with UT inspections of these welds.

All of the one-time inspections, committed to as a part of the license renewal process, appear to have been carried out, and the resulting observations have been addressed. No significant issues with respect to this program were identified during the audit.

B.18 Fuel Oil Chemistry (LRA Section B.3.10)

Associated GALL Report AMP: **2001 GALL Report, XI.M30 Fuel Oil Chemistry**

B.18.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

(Note: There was no worksheet prepared nor an audit report prepared)

B.18.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.18.5. Documents Reviewed during the Audit

1. CR AR 25444, Contaminants Found In Unit 1 Lighting Fuel Oil Tanks
2. IN 2006-22, New Ultra-low-sulfur Diesel Fuel Oil Could Adversely Impact Diesel Engine Performance.
3. IN 2009-02, Biodiesel In Fuel Oil Could Adversely Impact Diesel Engine Performance.
4. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
5. RAI B.3.10-6

B.18.6. Summary

RNP implements this program through its Fuel Oil Chemistry Program (AMP B.3.10). The aging effects/mechanisms of concern are loss of material due to general, crevice, and pitting corrosion in carbon steel, and loss of material due to MIC in carbon steel, copper alloys, and stainless steel. The RNP LRA states that this program is consistent with GALL, Revision 0, AMP XI.M30 “Fuel Oil Chemistry” with the following exceptions:

- In addition to storage tanks, the program is used to manage aging effects on all system components “wetted” by fuel oil. This results in additional materials being in scope beyond those in GALL.

- Based on operating history and fuel oil management activities, biocides, biological stabilizers, and corrosion inhibitors are not necessary and are not used in the fuel oil at RNP.

- Alternate standards and acceptance criteria are used for fuel oil sampling at RNP, in place of the ASTM standards recommended in GALL.

- UT measurements of bottoms on large storage tanks are not typically performed at RNP, unless warranted by the level of coating degradation and corrosion found during inspection.

A one-time inspection of small, elevated, diesel fire pump fuel oil tank and diesel generator day tanks is not warranted. These small tanks have limited access to the tank internals, making it impractical to clean and perform a meaningful inspection. UT is also considered inappropriate to detect small amounts of pitting in tanks constructed of carbon steel that is measured in units of gauge thickness (e.g., diesel fire pump fuel oil tank is made of hot rolled, 12 gauge steel). Based on operating history, external tank and structure inspections are considered sufficient to identify degradation in the tank walls. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Consider the preceding thoughts.

As a result of the license renewal review, the following enhancements were made to the program: (1) Improve sampling and de-watering of selected storage tanks, (2) formalize existing practices for draining and filling the diesel fuel oil storage tank periodically, (3) formalize bacteria testing for fuel oil samples from various tanks, and (4) incorporate quarterly trending of fuel oil chemistry parameters.

During the audit, it was stated that the diesel fuel for Robinson complex is delivered to Unit 1, an adjacent coal-fired generating plant, and the nuclear plant Unit 2 obtains its supply by pipeline from Unit 1. It was noted that Unit 1 had been shut down but not decommissioned, so the fuel oil control system through Unit 1 was still functional.

RNP stated that fuel oil for delivery to the site is sampled before loading into the tanker to ensure quality, and the tanker is then sealed. No acceptance sampling of fuel oil is performed upon delivery. The audit team noted Robinson CR AR 25444 (“Contaminants Found In Unit 1 Lighting Fuel Oil Tanks”) that described an incident, in which fuel oil delivered to Unit I was found to be contaminated by impurities in the tanker. It was determined that there is no assurance the contract carrier tankers were re-cleaned thoroughly, prior to loading of the fuel oil. The audit team noted that the present procedure of sampling the fuel, before it was loaded into the tanker, and not at the off-load point, would not prevent a recurrence of this sort of incident. RNP responded that present procedures call for monthly sampling of the fuel oil tanks for impurities, except for bacteria, for which analyses are performed on a quarterly basis. There are no plans to add biocides to the fuel oil, as stated in the program exceptions above.

With respect to the last sentence in the fifth exception listed above ("external tank and structure inspections are considered sufficient to identify degradation in the tank walls"), the question was raised as to how external inspection of fuel oil tanks, alone, could detect degradation before it has led to imminent or actual tank failure. In response, the RNP staff stated that this exception had been discussed and answered to the satisfaction of the NRC during license renewal in RAI B.3.10-6, as discussed in the SER. The RNP response to this RAI stated that there was no history of failures for the tanks in question and that, for a variety of reasons, there is no reason to suspect that the integrity of these day tanks is in question.

The auditors pointed out NRC IN 2009-02 ("Biodiesel In Fuel Oil Could Adversely Impact Diesel Engine Performance"). This IN notes that diesel fuel oil containing up to 5% biodiesel can have a cleaning effect that loosens accumulated sediment in fuel oil storage tanks that previously stored conventional diesel fuel. This sediment can then plug filters and other equipment in the fuel oil system. The RNP personnel stated that they did not believe that biodiesel fuel oil had been used at the plant and that they would check on the RNP response to this IN.

The auditors also pointed out IN 2006-22 ("New Ultra-low-sulfur Diesel Fuel Oil Could Adversely Impact Diesel Engine Performance"). This IN notes several potential problems related to the use of ultra-low-sulfur diesel fuel, specifically in the areas of (1) reduced energy content, resulting in increased fuel consumption, (2) fuel particulate buildup, (3) fuel system seal leaks, (4) compatibility with lubricating oil, (5) microbial growth, (6) incompatible metals, and (7) possible reduced lubricity. Again, the RNP personnel stated that they would check on the RNP response to this IN.

B.19 Flux Thimble Eddy Current Inspection Program (LRA Section B.2.8)

Associated GALL Report AMP: **2001 GALL Report, No Corresponding AMP (2005 GALL, XI.M37 Flux Thimble Tube Inspection)**

B.19.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.2.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	This is a plant specific program, since the associated GALL Report did not contain the AMP for flux thimble tubes. The LRA credits its plant specific program for aging management of incore flux thimbles, which is based on the requirements of NRC Bulletin 88-09 for tube wear.	No significant issue or further review item was identified.
1. Scope of Program	The Flux Thimble Eddy Current Inspection Program is based upon current plant activities delineated in an existing procedure governing flux thimble eddy current inspection. The procedure was implemented to satisfy NRC Bulletin 88-09 requirements that a tube wear inspection procedure be established and maintained, for Westinghouse supplied reactors that use bottom mounted flux thimble tube instrumentation.	No significant issue or further review item was identified. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): The scope of this AMP should be expanded to at least note other degradation mechanisms for this high-fluence component, and include, by reference, the relevant other AMPs for managing these aging effects: SCC, IASCC, and void swelling. The related AMPs would be, e.g., the Water Chemistry Program and the Vessel Internals Program
2. Preventive Actions	The Flux Thimble Eddy Current Inspection Program is a condition-monitoring program; therefore, there are no preventive actions.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	The aging effect to be managed by the Flux Thimble Eddy Current Inspection Program is loss of material due to wear in the double-walled, incore flux thimble tubes. This program is designed specifically to detect and manage that aging effect.	No significant issue or further review item was identified. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): This element of the AMP should be reviewed in light of the industry OE, since the original GALL report was issued to assess if parameters other than the volumetric wear be included to address other aging degradation effects. ***Technical Basis*:** The inspection program for these tubes is currently limited and focused only on tube volumetric

Program Element	Element of Licensee's AMP (LRA Section B.2.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		wear, whereas other potential mechanisms, including SCC, IASCC, and void swelling, seem pertinent for LTO, and lack confirmatory root cause evaluations of most instances related to the flux thimble tube events in the past.
4. Detection of Aging Effects	The Flux Thimble Eddy Current Inspection Program is a periodic volumetric examination that allows a projection of the rate of wear of the double-walled, incore flux thimble tubes. It is performed at a variable frequency, dependent on extrapolation of wear rates determined from previous inspections. This ensures that timely corrective action will be performed well before the projected failure of any of the tubes (due to wear) could occur.	**ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Consider what technique or enhancement, if any, is used to detect for cracking with or without wear. Consider if the current inspection program includes detection of damage to the inner and outer walls of the double-wall tubes, and what the frequency of inspection based on. For LTO, in conjunction with very long inspection interval, define how the extrapolation basis accounts for any significant difference between the potential damage rate for an individual location versus the observed damage rate averaged over all locations.
5. Monitoring and Trending	The Flux Thimble Eddy Current Inspection Program projects the rate of wear of the double-walled, incore flux thimble tubes, ensuring that timely corrective action will be performed well before failure of any of the tubes (due to wear) could occur.	The most recent change to inspection frequency, as noted in ADAMS ML091100397, has lengthened the inspection interval from originally, two-skip (once every other refueling outage to), to five-skip (i.e., inspection interval of six operating cycles or about nine years). The Industry personnel were asked how this new interval compares with the industry-wide range for current implementations of this AMP.
6. Acceptance Criteria	The administrative controls for the Flux Thimble Eddy Current Inspection Procedure provide specific, objective acceptance criteria that ensure that any thimble tube that is expected to experience through-wall wear, greater than the ASME criteria specified for the examination, prior to the next inspection, is removed from service. No subjective analysis that might permit a marginal tube to be returned to service is permitted by the procedure.	Describe how the presence of age-related cracking such as SCC, IASCC, or fretting, will be adequately addressed by the initial acceptance criteria, with the modified inspection interval over the PEO. (Essentially, it seems that the six-cycle interval would mean only one – or two depending on when the latest inspection was done – inspection planned for the entire PEO).

Program Element	Element of Licensee's AMP (LRA Section B.2.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
7. Corrective Actions	Corrective actions including root cause determinations and prevention of recurrence are done in accordance with the corrective action program. Timeliness of corrective action is monitored.	There were two tubes noted in the LRA to have caused leaks while under the plant-specific program – for which the root cause could not be determined. The discussion considered how (or with what change to the original program) is the timeliness of action and prevention of recurrence ensured for the PEO.
8. Confirmation Process	Effectiveness of this AMP will be monitored using corrective action program and quality assurance procedures, review and approval processes, and administrative controls which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	RNP corrective action and quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B of 10 CFR Part 50 and will continue to be adequate for the period of extended operation.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The LRA noted that a review of condition reports identified two involving thimble tubes. Both of the condition reports identified thimble tubes with very small leak rates. The leaks were evaluated under the corrective action program; however, the root cause of leakage could not be determined. Corrective action involved replacing the thimble tubes.	The H. B. Robinson's update on the NRC Bulletin 88-09 (ADAMS ML091100397, dated April 2009) stated that, "there are a total of 50 thimble tubes, three of which were intentionally plugged or capped, but not because of tube leaks." The audit discussed the reason for removing these three tubes from service, and how these observations relate to the two tubes with leaks noted in the LRA. If the root cause of the earlier two leaks was not determined, and one of these leaks did not involve any wear degradation, the AMP needs to define how to ensure timely corrective action, given the much longer inspection interval planned during the PEO. **No action items** for consideration for SLR-GD revisions.

B.19.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

1. The underlying concern for aging management of thimble tubes is same as identified in the basis NRC Bulletin 88-09, namely, that (a) the tubes form a significant primary pressure boundary, (b) any leakage from this boundary has the potential for being non-isolable, and (c) the tube degradation is highly site-specific. To this list one must also add the potential for a common cause in multiple tubes. The program limitation to manage only wear, especially when several leakage events have remained unexplained both at RNP and industry-wide – with some in the absence of any wear, in this high-fluence component, is of concern for the very LTO.

2. According to NRC IR 2010008 (February 2010) "Commitment #11 specified that the existing Flux Thimble Eddy Current Inspection Program will be credited for license renewal with no planned changes." The IR also noted that, "the inspectors examined records of the last thimble tube eddy current inspection conducted in September 2005. Based on past positive results, RNP has currently extended the frequency of inspection to every third refueling outage." H. B. Robinson's update on the NRC Bulletin 88-09 (ADAMS ML091100397, dated April 2009) stated that the frequency was being changed from every third fueling outage to every sixth refueling outage. Some clarification is needed on the actual current inspection frequency for this AMP, supporting basis, and the post-approval schedule of actual and planned inspections.

B.19.5. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
3. Bulletin 88-09, Status Update for, H. B. Robinson, Serial: RNP-RA/09-0025, ADAMS ML091100397, 4/13/2009.
4. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
5. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
6. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
7. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004

B.19.6. Summary

RNP LRA Section B.2.8 summarizes RNP's Flux Thimble Eddy Current Inspection Program for incore flux thimble tubes as a plant specific program since the associated GALL Report (Rev.0, 2001) did not contain the AMP for flux thimble tubes. The LRA credits its plant specific program for aging management of incore flux thimbles for loss of material due to mechanical tube wear. The Flux Thimble Eddy Current Inspection Program was based upon plant activities delineated in an existing procedure governing flux thimble eddy current inspection at the time of RNP's LR application. The procedure was implemented, to satisfy NRC Bulletin 88-09 requirements that a tube wear inspection procedure be established and maintained for Westinghouse supplied reactors, which use bottom mounted flux thimble tube instrumentation. While at the time of RNP's license renewal application, the GALL Report did not have a recommended AMP; their plant specific AMP is very similar to the current GALL Report (Rev.2) AMP XI.M37 for the flux thimble tubes.

The GALL AMP XI.M37 is inspection based condition monitoring program, and does not suggest any preventative actions for managing the tube wear; the staff enquired if RNP had any preventative action elements in its plant-specific program in the past, or considered it for future implementation, and noted that such consideration was not given by RNP, because of the good performance of these tubes in service over a long period. The staff further reviewed the status of RNP's AMP B.2.8, and discussed its implementation results with the RNP personnel. RNP noted that its plant specific program has met the requirements of NRC Bulletin 88-09 for tube wear, and that the related inspections utilize an eddy current technique (with calibration for wear only and not for crack-like indications) that examines both the inner and outer walls of the RNP's thimble tubes with double-wall design, which is somewhat unique to RNP.

RNP affirmed that the acceptance criteria are specified for both the walls, and that no wear of inner tubes has been detected in the existing thimble tubes, although some wear of outer walls has been seen in several tubes. According to RNP all original tubes were replaced in 1987-88 period, subsequent to which, 20 (like-for-like) tubes were replaced, due to thermocouple failure issues (non-aging related). RNP also confirmed that only two tubes were plugged (later replaced) for aging related damage leading to leaks: One (F13) in 1996 (for wear) and the other (J07) in 1999, of which J07 did not show any wear and that the leak was attributed to micro-cracking; both were considered to be isolated events. The staff asked about the three tubes intentionally plugged or capped (removed from service after the LRA), and if these had wear or cracking associated as the cause; RNP indicated that these were not related to wear, but due to mechanical failure or foreign material blocking their free movement within the assembly.

The staff reviewed the more recent inspection findings from the RNP's AMP since the LRA was approved; RNP indicated that there was only one inspection (in 2005) performed. Staff's review of these results showed no significant wear or wear rate was being observed in the double-wall tubes at RNP. The staff also asked for RNP's basis and view concerning the planned schedule for these inspections in the PEO; RNP indicated that there will be two more inspections (about 2014 and 2023), and that its recent observations of wear frequency and wear rate have been low enough to support this extended schedule.

Based on the above review and recent good performance of the tubes in service, there was no specific suggestion identifiable for improving the GALL AMP for subsequent license renewal; it is possible that the double-wall design changes the vibration characteristics of these tubes favorably, but because of the design being unique to RNP and because no assessment of plant operation or other influence factors has been performed, it is uncertain if such performance improvement can be generalized. Notwithstanding the recent good performance of these tubes at RNP, the AMP limitation to manage only wear, especially when several leakage events have remained

unexplained, both at RNP (in the past) and industry-wide (some absent of any wear), is of some concern for LTO in this high-fluence component, which may be useful to further/fully assess.

B.20 Selective Leaching of Materials Program (LRA Section B.4.52)

Associated GALL Report AMP: **2001 GALL Report, XI.M33 Selective Leaching of Materials**

B.20.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Worksheet table evaluating the 10 elements of the AMP to identify items of concerns or inadequacies was not prepared. See section 5.1.20 of TLR for recommendations related to writing SLR-GDs.

B.20.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.20.5. Documents Reviewed during the Audit

1. AR 85018, License Renewal Commitment 35; Selective Leaching, Site Fire Protection System
2. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.

B.20.6. Summary

RNP implements this program through its AMP B.4.52 “Selective Leaching of Materials Program.” The RNP LRA describes this as a new program that involves a one-time inspection and mechanical test of selected components judged to be susceptible to selective leaching. The program is stated to be consistent with GALL, Revision 0, with one exception that involves the use of mechanical means, other than Brinell hardness testing identified in GALL, to identify the presence of selective leaching of material. During the audit, RNP clarified that the “mechanical test” used to detect selective leaching was tapping (to check for mechanical resonance) and scraping of the component surface.

The one-time inspection of susceptible components identified four of 35 gray cast iron valve bodies in the Service Water System that had undergone selective leaching (graphitization). Leaching was determined to have progressed to a depth of approximately 3/32 in. No field hardness measurements were made in accordance with the exception to GALL, Revision 0, described above. Two of the valve bodies were "aggressively sand blasted, and after all of the graphite was removed, measurements were taken to assure adequate valve wall thickness prior to coating and reuse." Based on the observed corrosion rate, the valve bodies were judged to have adequate wall thickness for at least 20 years of additional service. No destructive metallography or similar examinations were performed.

In the Fire Water Protection System, the valves are brass or bronze and the underground cast iron piping is coated on the outer surfaces. No selective leaching was observed in the valves or the system heat exchangers. Opportunistic inspections of the underground piping outer surfaces found the coating to be intact, with no evidence of corrosion or selective leaching. The internal surfaces were also inspected opportunistically, and again, no corrosion or selective leaching was observed. Total 27 such inspections were performed, and it was concluded that selective leaching is not a problem in this system.

The reviewers noted that the Service Water System valve bodies and the Fire Water Protection System piping were treated by RNP as two separate populations, even though they were both gray cast iron and both served in contact with service water. Thus, RNP determined that the selective leaching, observed in the four Service Water System valve bodies, did not require additional inspections to be performed on the Fire Water Protection System piping. The reviewers questioned this determination during the review, and expressed the desire that future components, found to have undergone selective leaching, be subjected to destructive examinations, perhaps by EPRI. The reviewers also noted that Interim Staff Guidance on selective leaching is being developed by the NRC.

Subsequent to the audit, the reviewers reviewed documentation provided by RNP personnel on their selective leaching activities (AR 85018 – License Renewal Commitment #35; Selective Leaching – Site Fire Protection System). This documentation stated that 25 gray cast iron components from the Fire Water Protection System had been field inspected (visual and tapping), and 12 of these were subsequently subjected to destructive metallography. Based on this, the reviewers concluded that the sample size for the Fire Water Protection System Piping was adequate. However, the desire for destructive examinations of future components that exhibit selective leaching remains.

B.21a Buried Piping and Tanks Inspection (LRA Section B.3.12)

Associated GALL Report AMP: **2001 GALL Report, XI.M41 Buried and Underground Piping and Tanks**

B.21a.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.12)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	RNP has no formal "Buried Piping Program." Instead, a collection of activities governed by RNP procedures are used to implement the program elements. These activities are used to manage aging effects in underground, carbon steel, and cast iron and ductile iron piping, fittings and components. RNP uses inspections and coatings, such as wrappings and lining, to manage loss of material for coated piping. Uncoated piping, such as the cast iron and ductile iron underground fire protection piping is managed by inspection. The aging effects/mechanisms managed by this program are as follows: • Loss of Material due to Crevice Corrosion • Loss of Material due to General Corrosion • Loss of Material due to MIC • Loss of Material due to Pitting Corrosion • Loss of Material due to Galvanic Corrosion	The reviewers considered in this AMP meet the requirements of the Nuclear Strategic Issues Advisory Committee (NSIAC) Buried Piping Integrity Initiative and NEI 09-14, "Guideline for the Management of Buried Piping Integrity."
1. Scope of Program	RNP document EGR-NGGC-0351 provides general guidance for site implementing procedures to "Ensure maintenance programs include visual examinations when piping is made accessible by excavation. TMM-104 includes guidance for condition monitoring of inaccessible structures including piping systems. The scope of TMM-104 covers buried components that are within the scope of license renewal for the plant. The AMP as described in the LRA lists the following	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.12)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	exceptions to GALL: • The Program contains no buried tanks. • The Program includes additional components, i.e., underground Fuel Oil System piping, within the scope of the Buried Piping and Tanks Surveillance Program. • In addition to carbon steel components, buried cast iron fire water piping and fittings were included in this program. • The Program includes galvanic corrosion as a potential aging mechanism.	
2. Preventive Actions	Fuel Oil and Service Water underground carbon steel piping was coated during installation with a protective coating system, in accordance with industry practice at the time of construction (or later modifications). Protective coating of buried carbon steel piping is standard practice. The design change process, as prescribed in EGR-NGGC-0005, specifically addresses coatings and ensures a review by the appropriate engineering discipline. Cast iron and ductile iron fire protection piping does not require coating, due to the more corrosion-resistant nature of the material.	Industry personnel were asked if their operating experience and inspection results borne out their assumption that the cast iron and ductile iron fire protection piping does not require coating. **Consideration for writing SLR-GDs** (as result of audit): More detail on how RNP addressed the deficiencies cited in the 2008 and 2011 assessments would be helpful, particularly since similar problems with the cathodic protection systems occurred at several other plants, including Indian Point 2 (ML101760345), Clinton (EA-96-412), South Texas 1 and 2 (ML112800109), Seabrook (ML111360432), and Fermi 2 (ML112991353).
3. Parameters Monitored/ Inspected	As a result of the license renewal review, the program elements associated with *Parameters Monitored/Inspected* and *Acceptance Criteria* for the Program will be enhanced to: • Incorporate a requirement to ensure an appropriate as-found pipe coating and material condition inspection is performed, whenever buried piping within the scope of this Program is exposed. • Add precautions to ensure backfill with material that is free of gravel or other sharp or hard material that can damage the coating. • Add a requirement that coating inspections be	The Robinson Buried Piping Self-Assessment No. 447729 (9/13/11 – 9/15/11), Attachment 7, states in several places that "(1) program documentation requirements were not being met, (2) License Renewal buried piping inspections were not being performed in accordance with requirements, even though the required forms were being vaulted into RMS, (3) a portion of the Cathodic Protection System for the Emergency Diesel Generator buried piping has been inoperable for over one year, and portions of the system have been inoperable numerous times since the World Association of Nuclear Operators (WANO) made a similar finding several years ago, and (4) personnel turnover and

Program Element	Element of Licensee's AMP (LRA Section B.3.12)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	performed by qualified personnel to assess coating condition. • Add a requirement that a coating engineer should assist in evaluation of any coating degradation noted during the Inspection.	organizational changes have significantly challenged the successful turnover of program activities to the current Buried Piping Program Manager designate." The conclusion was that "The programs at RNP and HNP are not meeting program expectations." Industry personnel were asked what corrective actions have been taken since that self-assessment.
4. Detection of Aging Effects	EGR-NGGC-0351 and TMM-104 direct the inspection of underground piping when it is exposed for maintenance or for some other reason. OE demonstrates that leaks in high volume systems can be detected. Scheduled periodic inspection is not warranted, due to the small number and causes attributed to these failures as found in site OE. Sampling and scheduled inspections of underground pipe would become warranted, if observations of defective protective coatings or losses of material on external surfaces of piping were seen during inspections. This would be an outcome of the corrective actions needed to resolve pipe corrosion and/or coating imperfections. The Service Water System can tolerate a high leakage rate and still achieve its safety function (CR 99-0196). Additionally, a jockey pump normally maintains the Site Fire Protection system headers at an elevated pressure. Inability of the jockey pump to maintain header pressure would provide adequate notice of potential leakage in buried fire water system piping. In its response to RAI B.3.12-3a and RAI B.3.12-4, the applicant stated that the inspection frequency for buried piping would depend primarily on maintenance and modification activities. There are no schedule frequencies for excavations. If, during maintenance, degraded pipe coatings are identified, then an appropriate sample would be	The Robinson Buried Piping Self-Assessment No. 447729 (9/13/11 – 9/15/11), Attachment 7, states on pp. 11-12 that, "License Renewal commitments described in UFSAR 18.1.20 related to buried piping inspections are not being met." Industry personnel were asked what corrective actions have been taken since that self-assessment, and how many opportunistic inspections of the kind described in the LRA have been performed subsequent to license renewal. While it may be true that the Service Water System "can tolerate a high leakage rate and still achieve its safety function," this is not good engineering and plant operating practice. In addition, waiting for significant leaks to occur, and then correcting them, does not constitute an effective aging management program. **No action items** for consideration for SLR-GD revisions.

Program Element	Element of Licensee's AMP (LRA Section B.3.12)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	determined, based on engineering judgment and other relevant OE. LRA Section B.3.12 provides summary-level OE, regarding leakage in buried pipe due to corrosion from the external environment.	
5. Monitoring and Trending	Site experiences with corrosion of system components are used to ascertain additional inspections, when needed.	The Buried Piping Self-Assessment 447729 (2012) found that Buried Piping Program documentation at RNP is not being maintained in accordance with procedural requirements. Industry personnel were asked what remedial actions have been taken.
6. Acceptance Criteria	EGR-NGGC-0351 indicates that an "inspection checklist" shall be established for inspection of structures. Inspection checklists have been developed for structures and are provided in TMM-104. Evaluations are documented on Attachment 10.8 of TMM-104 The extent of the defective coatings or corrosion on the external surfaces of piping and applicable site experience will determine the nature of the corrective actions, including the need and locations of future inspections. See also enhancement under Program Element 3 above.	No significant issue or further review item was identified.
7. Corrective Actions		No significant issue or further review item was identified.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	According to the SER, the applicant reported that leaks have occurred in the north service water header pipe that was installed in 1984. In July 1995, March 1998, and September 1998, the leaks were identified and repaired. In a root cause evaluation, the applicant made three	Industry personnel were asked if there been any recurrences of pipe leakage subsequent to license renewal. The Program Health Report for the third quarter of 2012 states that RNP has committed to meeting all NSIAC deadlines and the Buried Piping Remediation initiative to

Program Element	Element of Licensee's AMP (LRA Section B.3.12)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	conclusions. First, the environmental conditions found at the location of the north service water header are not especially harsh. The soil has high resistance, which restricts the current flow and consequent corrosion. Second, the root cause of the March and September 1998 leaks was improper installation of the tapecoat external wrapping. The root cause of the July 1995 leak was damage from misoperation of a backhoe during initial installation of the piping. Third, regarding similar situations/generic implications, other buried pipe on site has not exhibited exterior corrosion, such as that experienced on the north service water header. Site experience shows that throughwall leaks have occurred in the Unit 1 IC turbine tank bottoms. Pitting corrosion initiated on the inside (fuel oil side), and eventually wore through the tank bottoms and caused these fuel oil leaks (CR 96-1803). During RFO20, the ten-year internal inspection of the Diesel Fuel Oil Storage Tank revealed pitting on the tank bottom, although it did not result in a through wall leak. Repairs are scheduled for RFO21 per ESR 01-00195.	address degraded piping, which will result in a complete condition assessment and asset management plan for all high risk piping, by June 30, 2014. This includes include buried tanks and piping below grade that are not in contact with soil, but are encased in concrete or in inaccessible vaults. However, the manpower and funding made available to meet this deadline has apparently been less than that required. This raises the potential risk of failing to meet NSIAC NEI 09-14 and License Renewal commitments. The report also states that the lack of priority for repair of the cathodic protection system for the buried Diesel Fuel Oil lines has resulted in extended periods where portions of the system were not functioning properly. There are no indications of degraded piping supported by the CP system; however, the system was installed to provide a safety barrier, and is expected to function properly. **Consideration for writing SLR-GDs** (as result of audit): Include OE related to problems with the cathodic protection systems at several other plants, including Indian Point 2 (ML101760345), Clinton (EA-96-412), South Texas 1 and 2 (ML112800109), Seabrook (ML111360432), and Fermi 2 (ML112991353).

B.21a.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.21a.5. Documents Reviewed during the Audit

1. Assessment 447729, Buried Piping Self-Assessment 2012 (9/13/11 – 9/15/11), Sept. 2011.
2. CR 96-1803.
3. CR 99-0196.
4. EA-96-412.
5. EC 65116, Cathodic Protection System Improvements.
6. EGR-NGGC-0005.
7. EGR-NGGC-0351, Rev. 18, Conditions Monitoring of Structures.
8. ESR 01-00195.
9. Fermi 2 (ML112991353).
10. Indian Point 2 (ML101760345).
11. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
12. NACE RP-01-69-76.
13. NACE Standard RP-0169, 1996.
14. NEI 09-14, Guideline for the Management of Buried Piping Integrity.
15. NSIAC Buried Piping Integrity Initiative.
16. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
17. Program Health Report, Buried Piping 3Q 2012, 12-3-2012.
18. RAI B.3.12-3a.
19. RAI B.3.12-4.
20. RNP-L/LR-0634, Rev. 4, Aging Management Program, Buried Piping and Tanks Inspection Program.
21. Seabrook (ML111360432).
22. South Texas 1 and 2 (ML112800109).
23. TMM-104, System Walkdown Procedure.

B.21a.6. Summary

At the time of license renewal, RNP was implementing this program through two separate AMPs, namely its Buried Piping and Tanks Surveillance Program (AMP B.3.8) and its Buried Piping and Tanks Inspection Program (B.3.12). The Robinson Buried Piping and Tanks

Surveillance Program is described in the LRA to be consistent with GALL, Revision 0, AMP XI.M28 ("Buried Piping and Tanks Surveillance") with the following exceptions:

- The RNP program uses the guidance in NACE RP-01- 69-76 in lieu of the 1996 standard. An enhancement will be made to review and update, as necessary, cathodic protection procedures to ensure consistency with NACE Standard RP-0169, 1996.
- There are no buried tanks in this program. The RNP cathodic protection system protects buried fuel oil system piping and the external, tank bottom surfaces of fuel oil system tanks in contact with the ground.
- Aspects of underground fuel oil system piping relating to coatings and inspections are included within the scope of the Buried Piping and Tanks Inspection Program in lieu of this program.
- No documentation of initial coating conductance is available. In-situ measurement of coating conductance is not considered prudent, due to the potential to cause coating damage during excavation and measurement, changing the local soil electrolytic conditions, or stressing the coatings due to changes in the local conditions of the supporting soil.
- The Buried Piping and Tanks Inspection Program, in lieu of this program, is used to determine the condition of pipe coatings when piping is exposed for any reason.

The Robinson Buried Piping and Tanks Inspection Program is similarly described in the LRA to be consistent with GALL, Revision 0, AMP XI.M32 ("Buried Piping and Tanks Inspection"), with the following enhancements incorporated as a result of the license renewal review:

- Incorporate a requirement to ensure an appropriate as-found pipe coating and material condition inspection is performed, whenever buried piping within the scope of this program is exposed.
- Add precautions to ensure backfill with material that is free of gravel or other sharp or hard material that can damage the coating.
- Add a requirement that coating inspections be performed by qualified personnel to assess coating condition.
- Add a requirement that a coating engineer should assist in evaluation of any coating degradation noted during the Inspection.

Subsequent to license renewal, the two AMPs have, for all intents and purposes, been merged into a single program, and this combined program is discussed here.

A considerable portion of the audit was devoted to discussions of the performance of the cathodic protection system. Numerous problems with the functioning of the cathodic protection system have been cited over the years, including the following:

- In a 1991 NRC inspection, the NRC determined that the cathodic protection system was known to have been operating outside of its original specification. The NRC found that only about 7 years of cathodic protection could be assured following the system's installation in 1981. Degradation of the cathodic protection system in 1988 appeared to have been caused by installation of concrete in the yard. Closure of this concern was based on an inspection of emergency diesel generator fuel oil underground piping that demonstrated the piping coating was intact with no detectable piping degradation.

- In 1996 and 2001, the Industry personnel assessed anomalies in data recorded during the monitoring of the cathodic protection system. The assessments recommended corrective action to be taken to repair the system. Nevertheless, the Industry personnel concluded that the as-found condition for substantial portions of the buried fuel piping indicated they had “some level” of cathodic protection prior to system repairs.

- In 2008, the CORRPRO Company performed a Cathodic Protection System assessment for RNP. This assessment determined that the Cathodic Protection System was operating in a degraded condition and required the installation of additional anodes to bring the system up to NACE Standards. In October 2009, EC 65116 (Cathodic Protection System Improvements) was completed to incorporate the 2008 recommendations of the CORRPRO assessment report.

The Robinson Buried Piping Self-Assessment No. 447729 (9/13/11 – 9/15/11), Attachment 7, stated that a portion of the cathodic protection system for the emergency diesel generator buried piping has been inoperable for over one year, and portions of the system have been inoperable numerous times since WANO made a similar finding several years ago.

In response, RNP stated that the problems identified in the 1991, 1996, and 2001 reports had been corrected prior to license renewal in 2004, as borne out by the SER, and the CORRPRO recommendations of 2008 to install additional anodes had been completed. They also stated that the self-assessment of 2011 applied largely to Robinson Unit 1, an adjacent fossil-fueled generating plant and that Unit 2 had “always” been protected “with some exceptions.” Presumably, this refers to the statement in this report that the cathodic protection system for the emergency diesel generator buried piping has been inoperable for over one year.

During the audit, RNP stated that inspections of the cathodic protection system are performed every three years, with plans to go to an annual inspection. Robinson monitors rectifier output levels monthly, but there appears to be no systematic trending of these data. They also stated that the cathodic protection system has been fully operational since October 2012, when two anodes were replaced.

Soil survey testing had been performed recently to assess soil corrosivity, with samples taken in the vicinity of piping, much of which was out of scope. However, these samples had not yet been analyzed. As part of an effort to bring the AMP into alignment with GALL, Revision 2, Robinson is doing directed inspections of underground piping, as well as opportunistic inspections. One such directed inspection identified a leak in a potable water line under a roadway, possibly related to rocks in the backfill. A similar inspection was performed on underground fire protection piping with similar backfill, and no problems were identified.

The Robinson Buried Piping Self-Assessment No. 447729 (9/13/11 – 9/15/11), Attachment 7, referenced above also stated the following:

- Program documentation requirements were not being met,
- License Renewal buried piping inspections were not being performed in accordance with requirements, even though the required forms were being vaulted into RMS, and
- “Personnel turnover and organizational changes have significantly challenged the successful turnover of program activities to the current Buried Piping Program Manager designate.”

The conclusion was that “The programs at RNP and HNP are not meeting program expectations.” In response to these findings, RNP personnel stated rather emphatically during the audit, that the deficiencies cited in this self-assessment were being actively addressed with new personnel and updated procedures. They added that the specific condition reports mentioned in this self-assessment had been closed down.

The chronic problems with the cathodic protection system over the years are a source of concern. The history of this system has been characterized by numerous failures and repairs, only to have new problems surface, and it is not clear that the Robinson has solved all of its problems with this system.

B.21b Buried Piping and Tanks Surveillance (LRA Section B.3.8)

Associated GALL Report AMP: **2001 GALL Report, XI.M41 Buried and Underground Piping and Tanks**

B.21b.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected. If there is an issue, include pertinent text from the program description.	The reviewers addressed if this AMP meet the requirements of the Nuclear Strategic Issues Advisory Committee (NSIAC) Buried Piping Integrity Initiative and NEI 09-14, "Guideline for the Management of Buried Piping Integrity."
1. Scope of Program	In an exception to GALL, the RNP program originally used the guidance in NACE RP-01-69-76 in lieu of the 1996 standard. The enhancement stated under Program Element 6 below to review and update, as necessary, cathodic protection procedures to ensure consistency with NACE Standard RP-0169, 1996, addresses this exception. In another exception to GALL, there are no buried tanks in the RNP program. The RNP Cathodic Protection System protects buried Fuel Oil System piping and the external tank bottom surfaces of Fuel Oil System tanks in contact with the ground. In a third exception, aspects of underground Fuel Oil System piping relating to coatings and inspections are included within the scope of the Buried Piping and Tanks Inspection Program, in lieu of this program. The exterior of the Diesel Fuel Oil Storage Tank and the three Unit 1 IC Turbine Fuel Oil Tanks are within the scope of the Above Ground Carbon Steel Tank Program. However, the exterior bottoms of these tanks are included within the scope of the present program. The	NRC IP 71003 Inspection Report 05000261/2010008 (April 7, 2010) found that this commitment (install pressure taps and perform leak testing) had been partially completed and that additional tasks were pending to be implemented prior to the period of extended operation. Industry personnel were asked if this commitment now been completed.

Program Element	Element of Licensee's AMP (LRA Section B.3.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Above Ground Carbon Steel Tank Program recommends a monitoring approach through measurement of tank thickness by ultrasonic testing means. The present surveillance programs relies on preventive measures, which is considered a more aggressive approach to aging management, and is therefore superior. The Cathodic Protection System protects the external, tank bottom surfaces in contact with the ground (electrolyte). In a fourth exception, no documentation of initial coating conductance is available. In-situ measurement of coating conductance is not considered prudent, due to the potential to cause coating damage during excavation and measurement, changing the local soil electrolytic conditions, or stressing the coatings due to changes in the local conditions of the supporting soil. In a fifth exception, the Buried Piping and Tanks Inspection Program, in lieu of this program, is used to determine the condition of pipe coatings, when piping is exposed for any reason. As an enhancement, Robinson agreed to install pressure taps and perform leak testing on the underground fuel oil piping from Unit 1 to the Unit 2 diesel fuel oil storage tank, and the underground piping from the diesel fuel oil storage tank to each emergency diesel generator day tank in the reactor auxiliary building (RAB).	
2. Preventive Actions	RNP uses an impressed current, cathodic protection system. See third exception under Program Element 1 above.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	In an exception to GALL, no documentation of initial coating conductance is available. In-situ measurement of coating conductance is not considered prudent, due to the potential to cause coating damage during excavation and measurement, changing the local soil electrolytic	The Robinson Buried Piping Self-Assessment No. 447729 (9/13/11 – 9/15/11), Attachment 7, states in several places that "(1) program documentation requirements were not being met, (2) License Renewal buried piping inspections were not being performed in accordance with requirements,

Program Element	Element of Licensee's AMP (LRA Section B.3.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	conditions, or stressing the coatings due to changes in the local conditions of the supporting soil.	even though the required forms were being vaulted into RMS, (3) a portion of the Cathodic Protection System for the Emergency Diesel Generator buried piping has been inoperable for over one year, and portions of the system have been inoperable numerous times since WANO made a similar finding several years ago, and (4) personnel turnover and organizational changes have significantly challenged the successful turnover of program activities to the current Buried Piping Program Manager designate." The conclusion was that "The programs at RNP and HNP are not meeting program expectations." Industry personnel were asked what corrective actions have been taken since that self-assessment.
4. Detection of Aging Effects	RNP monitors rectifier output levels monthly per PM-403 and directs the conduct of troubleshooting unexpected changes. Section 6.3 describes the resolution of rectifier output anomalies. The resolution of such anomalies has shown problems, due to piping configuration changes and other physical damage of installed protection equipment. Implicit in this finding is the conclusion that changes in rectifier settings are not due to coating degradation. In its response to RAI B.3.8-2b, the applicant stated that currently, fuel oil piping leak-testing is performed every 2 years. This testing is an enhancement to the program, since the pressure taps for the piping from the diesel fuel oil storage tank to the day tanks had not yet been installed at the time of the LRA submittal.	Industry personnel were asked if the pressure taps been installed and if so, is leak testing still performed at two-year intervals. (See also Program Element 1.)
5. Monitoring and Trending	In addition to the monitoring of coatings, RNP monitors rectifier output levels monthly per PM-403.	Industry personnel were asked if this monthly monitoring of rectifier output levels was in place prior to the 1991 NRC inspection and the 1996 and 2001 engineering evaluations that cited deficiencies in the performance of the cathodic protection system.

Program Element	Element of Licensee's AMP (LRA Section B.3.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
6. Acceptance Criteria	As a result of the license renewal review, the program elements of *Acceptance Criteria* and *Confirmation Process* of the Buried Piping and Tanks Surveillance Program will be enhanced to: • Review and update, as necessary, Cathodic Protection procedures to ensure consistency with NACE Standard RP-0169, 1996. The review should focus on Acceptance Criteria to ascertain the condition of the Cathodic Protection System LRA Commitment #19). • Install pressure taps and perform leak testing on the underground fuel oil piping from Unit 1 to the Unit 2 Diesel Fuel Oil Storage Tank and the underground piping from the Diesel Fuel Oil Storage Tank to each Emergency Diesel Generator (EDG) Day Tank in the RAB. In an exception to GALL, the Buried Piping and Tanks Inspection Program, in lieu of this program, is used to determine the condition of pipe coatings, when piping is exposed for any reason.	NRC IP 71003 Inspection Report 05000261/2010008 (April 7, 2010) found that Commitment #19 had been partially completed and that additional tasks were pending to be implemented prior to the period of extended operation. Industry personnel were asked if this commitment has now been completed.
7. Corrective Actions		No significant issue or further review item was identified.
8. Confirmation Process	See enhancement under Program Element 6 above.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The applicant reported that in a 1991 NRC inspection, the NRC determined that the cathodic protection system was known to have been operating outside of its original specification. The NRC found that only about 7 years of cathodic protection could be assured following the system's installation in 1981. Degradation of the cathodic	Numerous problems with the functioning of the cathodic protection system have been cited over the years (1991, 1996, 1998, 2001, and 2011). In each case, the underlying problems were addressed. Industry personnel were asked what assurances we now have, that this system is finally functioning properly. Industry personnel were asked what

Program Element	Element of Licensee's AMP (LRA Section B.3.8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	protection system in 1988 appeared to have been caused by installation of concrete in the yard. Closure of this concern was based on an inspection of emergency diesel generator fuel oil underground piping that demonstrated the piping coating was intact with no detectable piping degradation. In 1996 and 2001, the applicant assessed anomalies in data recorded during the monitoring of the cathodic protection system. The assessments recommended corrective action to be taken to repair the system. Nevertheless, the applicant concluded that the as-found condition for substantial portions of the buried fuel piping indicated they had "some level" of cathodic protection prior to system repairs. In 2008, the CORRPRO Company performed a Cathodic Protection System assessment for RNP. This assessment determined that the Cathodic Protection System was operating in a degraded condition and required the installation of additional anodes to bring the system up to National Association of Corrosion Engineers (NCAE) Standards. In October 2009, EC 65116 (Cathodic Protection System Improvements) was completed to incorporate the 2008 recommendations of the CORRPRO assessment report.	inspections have been performed, to evaluate the extent of any resulting degradation of underground components that are supposed to be protected by this system.

B.21b.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.21b.5. Documents Reviewed during the Audit

1. Assessment 447729, Buried Piping Self-Assessment 2012 (9/13/11 – 9/15/11), Sept. 2011.
2. EC 65116, Cathodic Protection System Improvements.
3. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
4. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
5. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
6. NACE RP-01-69-76.
7. NACE Standard RP-0169, 1996.
8. NEI 09-14, Guideline for the Management of Buried Piping Integrity.
9. NSIAC Buried Piping Integrity Initiative.
10. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
11. PM-403
12. RAI B.3.8-2b
13. RNP-L/LR-0629, Rev. 1, Aging Management Program, Buried Piping and Tanks Surveillance Program, June 2004.

B.21b.6. Summary

See Section B.19a.6.

B.22 Metal Fatigue of Reactor Coolant Pressure Boundary (LRA Section B.3.19)

Associated GALL Report AMP: **2001 GALL Report, X.M1 Metal Fatigue of Reactor Coolant Pressure Boundary**

B.22.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The RNP AMP B.3.19 "Metal Fatigue of Reactor Coolant Pressure Boundary (Fatigue Monitoring Program)" manages the aging effect/mechanism of thermal fatigue of select components in various NSSS and secondary systems, by monitoring the number of transients that were assumed in the fatigue design. In addition, the program element 2, Preventive Actions, has been enhanced to reduce the plant load/unload transient limit to provide the margin needed for consideration of reactor water environmental effects. RNP stated that the original plant design fatigue analyses were performed in accordance with ASME Section III for the reactor vessel, pressurizer, steam generators, and the reactor coolant pumps. Based on the anticipated operational transients for the 40-year license period, the CUF for all of these components was shown to be less than 1.0. Later, additional transients were postulated for surge line thermal stratification and pressurizer insurge/outsurge, and the CUF for the surge line and other affected pressurizer components was shown to be below 1.0. The RCS piping and components were designed in accordance with ANSI B31.1 Code, which imposed stress range reduction factors if the number of cycles exceeded specified limits. For license renewal, the number of transients experienced	RNP states that the environmentally adjusted fatigue CUFs for the pressurizer surge line and adjacent stainless steel nozzle and safe end components, could not be shown to be less than 1.0 using 60-year projected numbers of transients. In NRC SER Section 4.3.2.3, in response to NRC RAI 4.3-10, the licensee noted that the fatigue of the surge line will be managed using one or more of the following options: • Further refinement of the fatigue analyses to maintain the EAF-adjusted CUF below 1.0. • Repair of the affected locations. • Replacement of the affected locations. • Management of the effects of fatigue through the use of an augmented inspection program that has been reviewed and approved by the NRC. The licensee committed to provide the NRC with the details of the inspection program prior to the period of extended operation, if the last option is selected. The NRC Post-approval Site Inspection for License Renewal – IP 71003 report (dated Feb. 2010) stated the licensee had opted for further refinement of the pressurizer surge line fatigue analysis to maintain the EAF-adjusted CUF below 1.0. However, RNP calculation No. RNP-L/LR-0605, which documents and evaluates those activities of the AMP for

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	to-date was trended, and the 60-year transient projections were shown to be enveloped by the 40-year transient limits. The effect of reactor coolant environment on fatigue life was also evaluated for a sample of significant locations, including those specified in NUREG/CR-6260 and several B31.1 piping locations. With the exception for the pressurizer surge line and adjacent stainless steel nozzle and safe end components, the analyses showed that the environmentally-adjusted CUF values remain below 1.0 for 60 years.	Metal Fatigue of Reactor Coolant Pressure Boundary that are credited as part of license renewal, states in program element 7 "Corrective Actions" that the EAF-adjusted CUF evaluation for the stainless steel surge nozzle safe end was shown to exceed the design limit of 1.0, and that the surge nozzle safe end will be managed in the same manner as the remainder of the pressurizer surge line. No additional details are given about the management program activity. The NRC audit team should request the licensee to *confirm which option the licensee chose, and if further refinement is chosen to maintain the EAF-adjusted CUF below 1.0, to provide where the evaluation is documented.* Note that as mentioned in the LRA SER, <u>staff has not endorsed a procedure on a generic basis, which allows for ASME Section XI inspections in lieu of meeting the fatigue usage criteria</u>. In fact, licensee document RNP-L/LR-0605 in program element 7-1, also notes that NRC has indicated that any inspection approach must be in conjunction with a CUF below 1.0. Therefore, inspection without demonstrating CUF <1.0 is not an acceptable option for the licensee. . **Consideration for writing SLR-GDs** (as result of audit): Revise the program description to provide specific guidance for managing the effects of metal fatigue of reactor components, in accordance with the requirements of 10 CFR 54.21(c)(iii). In particular, clarify whether the GALL AMP X.M1 endorses a program on a generic basis that allows for ASME Section XI inspections, in lieu of meeting the fatigue usage criteria. Confirm whether the SER for MRP-227 may have accepted an inspection program for reactor core support structures and reactor internals even to manage cracking due to fatigue or corrosion fatigue, without any supporting fatigue CUF analysis.

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
1. Scope of Program	The RNP AMP B.3.19 includes Procedure PLP-109, Rev. 4 "Cycle and Transient Monitoring" that monitors the bounding primary system transient cycles, to assure that transient limits are not exceeded for the ASME Section III fatigue CUF analyses for the components. These results are considered bounding for the RCPB components and secondary side components listed in SIR-00-166 Rev. 1 "Review of Plant-Specific Fatigue Program at H.B. Robinson Nuclear Plant to Support License Renewal Efforts."	No significant issue or further review item was identified.
2. Preventive Actions	RNP-L/LR-0605 "Metal Fatigue of Reactor Coolant Pressure Boundary," noted that for the pressurizer spray nozzle safe end, a lower number of transient cycles was assumed to demonstrate that the CUF value is below 1.0 for the 60-year period. The reduced number is used as the transient limit in this AMP to ensure that it will not be exceeded.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	As recommended by the GALL AMP, calculation RNP-L/LR-0502 "Thermal Fatigue TLAA Review," includes a review of the RNP design transients used in the fatigue design analyses, to determine which ones have a significant contribution to fatigue usage for one or more reactor coolant pressure boundary components. These transients are monitored by this program (using procedure PLP-109), and considered to provide leading indicator of plant operation, which permits timely preventive action to assure that the limits are not exceeded.	*Review* RNP-L/LR-0502 *to check which plant transients are typically considered to contribute the most to fatigue usage and selected for monitoring by this AMP.* In addition, regarding transients monitoring, the bottom line is the licensee's need to monitor all transients that are used in the fatigue calculation, not just those transients that "contribute the most to the fatigue usage." This requires justification, if all transients are not monitored. Therefore, the audit team should request the licensee to *confirm that the program monitors all transients that are included in the fatigue CUF calculations, and that adequate justifications are provided if certain transients are not monitored.* Furthermore, the Fatigue Monitoring program states that the number of occurrences of the specified thermal transients is kept below the number assumed in the ASME Section III fatigue analyses, and below the number

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		assumed in the environmental fatigue calculations. However, the *RNP documents do not specify whether the actual number of design cycles is used to trigger corrective actions or if there is some safety margin. Ask the licensee for additional details and clarification, and maybe review procedure PLP-109.* **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Revise the parameters monitored/inspected program element to clearly specify that all design transients used in the fatigue design analyses need to be monitored by the licensee's AMP B.3.19 and not just those transients that have a "significant" contribution to fatigue usage, and that adequate justification is provided if certain transients are not monitored.
4. Detection of Aging Effects	(From RNP-L/LR-0605) Fatigue usage calculations are not periodically updated, but are revised, if changes to design input assumptions are made, such as a change to the postulated number or type of transients. *Enhancement*: The environmental fatigue evaluations for the pressurizer spray nozzle safe end (calculation RNP-L/LR-0502) are performed using a reduced number of load/unload transients, which are specified as revised limits that are monitored by this AMP. Similarly, a lower number of postulated transients was also used in the reanalysis of AFW/FW piping connections (evaluated in RNP-M/MECH-1593 and RNP-M/MECH-1594), which is used as the transient limit and is monitored in this AMP to assure that the assumptions made within the fatigue analysis remain valid. Both these are considered a program enhancement. The transient count summary is periodically updated, based upon a review of operation logs and other data, to assure that the number of transients experienced by the	The RNP documents do not clarify why the "reanalysis" of AFW/FW piping connections is not included in the program description or program scope. Industry personnel were asked if these analyses performed because of system modifications or because of a change in design transients. *Request RNP for this clarification.* **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Revise the detection of aging effects program element to provide specific guidance for managing the effects of metal fatigue of reactor components, in accordance with the requirements of 10 CFR 54.21(c)(iii).

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	plant does not exceed design limits.	
5. Monitoring and Trending	(From RNP-L/LR-0605) Environmental fatigue evaluations were performed for each of the locations identified in NUREG/CR-6260 and for five additional sample locations. Monitoring is performed by counting transients that lead to significant fatigue usage in these calculations and by comparing the cumulative totals to transient limits. Trending was performed in SIR-00-166, including 60-year transient projections, which showed that the 40-year design transients are conservative for 60 years.	Note that document RNP-L/LR-0605 states that monitoring is performed by counting transients that lead to significant fatigue usage in these calculations and by comparing the cumulative totals to transient limits. *It is not clear how the cumulative totals are compared with transient limits if the program does not monitor all transients that are considered in the CUF analyses. The audit team should request the licensee to clarify*. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Revise acceptance criteria program element to clarify that all design transients used in the fatigue design analyses need to be monitored by the fatigue monitoring program and not just those transients that have a "significant" contribution to fatigue usage.
6. Acceptance Criteria	(From RNP-L/LR-0605) The acceptance criterion, specified in the GALL report for this AMP, is that the CUF is maintained below 1.0. This is accomplished by assuring that the transient limits specified in the UFSAR are not exceeded. These limits are based upon the numbers of transients used as inputs in the fatigue analyses for RCS components, including those considering environmental effects. By maintaining the actual transient counts below the transient limits, the fatigue usage is kept below the design code limit. As discussed in program element 4, the EAF-adjusted CUFs for the pressurizer spray nozzle safe end and the AFW/FW piping connections were shown to be less than 1.0 by using a lower number of load/unload transients. *Exception*: The *EAF-adjusted CUF for the pressurizer surge line could not be shown to be less than 1.0 using 60-year projected numbers of transients of design basis*	The EAF adjusted CUF for the pressurizer surge line components could not be shown to be less than 1.0 using 60-year projected numbers of transients. This is considered an exception to the GALL AMP, and further action is required to manage the effects of environmental fatigue on the intended function of the pressurizer surge line. Additional details are described below in program element 7, Corrective Actions. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Revise acceptance criteria program element to provide specific guidance for establishing a CUF threshold for initiating planning activities for corrective action, when it cannot be demonstrated that the CUF value at any locations that are being monitored can be maintained below the fatigue limit of 1.0..

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	severity. RNP states that further action is required for management of environmental fatigue of the surge line for the period of extended operation.	
7. Corrective Actions	(From RNP-L/LR-0605) RNP stated that when it is determined that a transient count is approaching the design limit, corrective actions are taken to prevent the fatigue CUF from exceeding the design Code limit for the affected analyses. These actions include the following options: Refinement of the fatigue analyses to maintain CUF less than 1.0, or repair or replacement of the affected locations. *Exception*: RNP specified another option, which is an exception to GALL. RNP stated that the pressurizer surge line components would be managed for the effects of fatigue, using an NRC approved augmented ISI program. The program would include periodic surface and volumetric examinations of the limiting locations, at inspection intervals, to be determined by a method accepted by the NRC. The scope, qualification, method, and frequency will be provided for NRC review and approval, prior to the period of extended operation.	RNP stated that as a corrective action for the surge line environmental fatigue results, the sample size for evaluating environmental effects was increased beyond those specified in NUREG/CR-6260, and additional environmental fatigue calculations were performed for other reactor coolant pressure boundary locations. The previously analyzed locations inside the pressurizer were selected for reanalysis considering environmental effects, because they were exposed to cyclic loadings, similar to those imposed upon the surge line. The environmentally adjusted fatigue CUF for each of these locations was shown to remain within design Code limit of 1.0, except for the SS surge nozzle safe end. The nozzle safe end is welded to the surge line and will be managed in the same manner as the remainder of the pressurizer surge line. As discussed in Program Description, the NRC IP 71003 report (dated Feb. 2010) stated, "In addition, the inspectors verified which option the licensee selected to manage environmentally-assisted fatigue in the pressurizer surge line. The inspectors noted that the licensee opted for further refinement of the pressurizer surge line fatigue analysis to maintain the EAF-adjusted CUF below 1.0." It appears that the licensee has opted for "reanalysis." Furthermore, the "List of Documents" given in the IP 71003 report includes WCAP-16694-P, Environmental Fatigue Evaluations for H.B. Robinson Unit 2 Pressurizer and Surge line, April 2007. Therefore, he audit team should request the licensee to *confirm which option the licensee chose, and take a look at WCAP-16694-P to confirm that the EAF-adjusted CUF is below 1.0.* However, in case the licensee has opted for augmented ISI

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		program, the audit team *should ask the licensee to provide the scope, qualification, method, and frequency of the program. In addition, request the following details:* *Has the augmented ISI program been reviewed and approved by the NRC?* *Does the program identify the location where the fatigue usage is shown to exceed the design limit?* *Was a flaw tolerance analyses, using environmentally adjusted crack growth rates and loss of fracture toughness of associated welds (or CASS materials), performed to justify the inspection interval*? **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Revise the corrective action program element to include guidance for licensees that use the 54.21(c)(1)(iii) option and propose an inspection program to manage fatigue CUF TLAAs.
8. Confirmation Process		N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls		N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	RNP stated that based on worldwide OE, several additional thermal transients have been added that were not considered in the original design. These include thermal stratification of the pressurizer surge line, identified by NRC Bulletin 88-08, and insurge/outsurge transients associated with operation of the pressurizer, identified by NRC Bulletin 88- 11. More recently, cracking of unisolable branch lines attached to the RCS system has occurred, due to thermal stratification and striping. Industry guidelines have been developed to determine susceptibility to cracking of these lines, and the RNP	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.19)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	design has been updated. RNP stated that no susceptibility was identified. Industry experience was used in selecting the NUREG/CR-6260 locations evaluated for environmental fatigue. In addition, pressurizer locations were evaluated for environmental fatigue. RNP further stated that the GALL report is based on industry OE through April 2001. Recent industry OE (2001) has been reviewed for applicability. No findings that were related to thermal fatigue or to fatigue monitoring were identified. Subsequent OE will be captured through the normal OE review process (CAP-NGGC-0202 Rev. 3).	

B.22.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.22.5. Documents Reviewed during the Audit

1. 10 CFR 54.21.
2. Bulletin 88-08
3. Bulletin 88-11
4. CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.
5. EPRI TR-105759
6. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
7. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.

8. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
9. NUREG/CR-5704
10. NUREG/CR-6260
11. NUREG/CR-6583
12. PLP-025, Rev. 15, Inservice Inspection Programs, June 2004.
13. PLP-109, Rev. 4, Cycle and Transient Monitoring.
14. RAI, Response to, 4.3-10
15. RNP-L/LR-0605, Rev. 4, Aging Management Program for Metal Fatigue of Reactor Coolant Pressure Boundary (Fatigue Monitoring Program).
16. RNP-M/MECH-1593
17. RNP-M/MECH-1594
18. SIR-00-166 Rev. 1 “Review of Plant-Specific Fatigue Program at H.B. Robinson Nuclear Plant to Support License Renewal Efforts.”
19. WCAP-14209
20. WCAP-16694-P, Environmental Fatigue Evaluations for H.B. Robinson Unit 2 Pressurizer and Surge line, April 2007.

B.22.6. Summary

The RNP AMP B.3.19 “Metal Fatigue of Reactor Coolant Pressure Boundary (Fatigue Monitoring Program)” is an existing program that has been enhanced to manage the aging effect/mechanism of thermal fatigue of select components in various NSSS and secondary systems, by monitoring the number of transients postulated in the fatigue design. The number of transients are monitored and evaluated in accordance with RNP procedure PLP-109, and corrective action is taken when the value is within 10% of the design limit.

In the original plant design, explicit fatigue analyses were performed in accordance with ASME Section III for the reactor vessel, pressurizer, steam generators, and the reactor coolant pumps. Later, additional transients were added for surge line thermal stratification and pressurizer insurge/outsurge flow, reactor vessel internals, and thermal cycling of auxiliary feedwater to main feedwater (AFW/FW) connections. Explicit fatigue analyses are performed in accordance with ASME Section III Class 1 requirements; these analyses require that the fatigue cumulative usage factors (CUFs) for the components remain below 1.0.

In addition, implicit fatigue analyses were performed for (a) the reactor coolant system (RCS) piping and components designed in accordance with ANSI B31.1 Code, and (b) auxiliary heat exchangers designed in accordance with Westinghouse specifications G-676454 and ASME Section III, Class C, or ASME Section VIII requirements. These design codes required consideration of cyclic loading, but did not require formal fatigue analysis. Stress range reduction factors are imposed to allow for a specified number of cyclic loadings, which effectively reduces the allowable stress amplitude, and thereby mitigates fatigue damage to the component.

Calculation RNP-L/LR-0605 noted that fatigue usage calculations are not periodically updated, but are revised if changes to design input assumptions are made, such as a change to the postulated number or type of transients.

The RNP AMP B.3.19 includes the following enhancement: The environmental-fatigue evaluations for the pressurizer spray nozzle safe end (calculation RNP-L/LR-0502) are performed using a reduced number of load/unload transients, which are specified as revised limits that are monitored by this AMP. Similarly, a lower number of postulated transients was also used in the reanalysis of AFW/FW piping connections (evaluated in RNP-M/MECH-1593 and RNP-M/MECH-1594). Both of these are considered a program enhancement.

For license renewal, the number of transients experienced to-date was trended, and the 60-year transient projections were enveloped by the 40-year transient limits. The effect of reactor coolant environment on fatigue life was also evaluated for a sample of significant locations, including those specified in NUREG/CR- 6260 and several B31.1 piping locations. The following 7 locations were evaluated for environmental fatigue: (i) RPV shell at the core support pads, (ii) RPV outlet nozzle, (iii) RPV inlet nozzle, (iv) pressurizer surge line, (v) charging nozzle, (vi) safety injection nozzle, and (vii) RHR tee. The first four were performed in accordance with ASME Section III, and the others in accordance with USAS B31.1 design requirements. The environmental fatigue reduction factors (F_{en}) were computed in accordance with EPRI TR-105759, which follows the guidance of NRC documents NUREG/CR-6583 for carbon steels and NUREG/CR-5704 for austenitic stainless steels.

With the exception for the pressurizer surge line and adjacent stainless steel nozzle and safe end components, the analyses showed that the environmentally adjusted CUF values remain below 1.0 for 60 years. However, during the audit, RNP stated that the AFW/FW nozzles and piping connections (evaluations RNP-M/MECH-1593 and -1594), particularly the AFW nozzles, are more limiting than the pressurizer surge line safe end. The 50-year projected CUF is 0.98 for these nozzles; the nozzles are scheduled for replacement during the next outage.

In NRC SER Section 4.3.2.3, the licensee noted that the fatigue of the surge line would be managed using one or more of the following options:

- Further refinement of the fatigue analyses to maintain the EAF-adjusted CUF below 1.0.
- Repair of the affected locations.
- Replacement of the affected locations.
- Management of the effects of fatigue by using an augmented inspection program reviewed and approved by the NRC.

The licensee committed to provide the NRC with the details of the inspection program, prior to the period of extended operation, if the last option is selected. The NRC Post-approval Site Inspection for License Renewal – IP 71003 report (dated Feb. 2010) stated the licensee had opted for further refinement of the pressurizer surge line fatigue analysis to maintain the EAF-adjusted CUF below 1.0. However, the licensee has neither demonstrated that the environmentally adjusted fatigue CUF analysis for the pressurizer spray nozzle safe end will remain less than 1.0 during the period of extended operation, nor submitted an augmented inspection program for NRC review and approval. For this component, F_{en} was estimated to 15.35 and fatigue CUF in air for 60-year operation (using 19,000 transients) was 0.96.

Similar information for the AFW/FW nozzle is not available on the Robinson portal. However, the NRC SER for RNP LRA states that in 1972, the applicant reported leakage, attributed to thermal fatigue cracking, at the 4"x16" connection between the AFW and main FW lines upstream of steam generator B. The AFW/FW connection was replaced with thermal-sleeved tees designed to ASME Section III, Subsection NB requirements. A fatigue analysis of the branch connection reinforcement plate was shown to be less than 1.0 for the 40-year as well as 60-year operation. Since these branch connections are nonstandard components, during RNP LRA review, the staff requested the applicant to provide fatigue CUF for these six branch connections, as well as any other nonstandard components. RNP noted that the three branch connections downstream from the motor-driven pumps were replaced with the better design, employing a thermal sleeve after the leakage was detected. The three connections downstream from the steam-driven pumps were not replaced. Although one of these has gone through design modification, to make it comparable to the other two designs (saddle reinforcing plate design replaced by a pad-type reinforcing plate), the fatigue CUF is expected to exceed the limit after approximately 50-year operation (i.e., July 2020). RNP noted that these connections are scheduled for replacement during the next outage.

Calculation RNP-L/LR-0502 "Thermal Fatigue TLAA Review" states that the number of design transients included in the applicable Westinghouse specifications is identified in Table 2-2 of SIR-00-166 Rev. 1. The number is based upon conservative estimates of the number of operational, test, and upset events expected to occur during the original 40-year license period. The normal operational transients include plant heatup/cooldown, plant loading/unloading, step increase/decrease, etc. Test condition transients include primary and secondary hydrostatic pressure tests, primary and secondary leak tests, and primary-to-secondary and secondary-to-primary leak tests. Upset condition transients include reactor trip, loss of load, loss of AC power, partial loss of flow, and loss of secondary pressure. RNP further noted that except for the plant heatups, cooldowns, and turbine trip, all other transients were conservatively extrapolated to 60 years based on the actual average number of transient per year to date. For heatup, cooldown, and turbine trip transients, extrapolation were based on a "learning curve effect;" transient accumulation rate observed after system shakedown was used for extrapolation.

As recommended by the GALL AMP, calculation RNP-L/LR-0502 includes a review of the RNP design transients used in the fatigue design analyses, to determine which ones have a <u>significant contribution to fatigue usage</u> for one or more reactor coolant pressure boundary components. These transients are monitored by this program (using procedure PLP-109), and are considered to provide leading indicator of plant operation, which permits timely preventive action to assure that the limits are not exceeded. RNP-L/LR-0502, Section 6.4.2 states that Table 2-2 of SIR-00-166 Rev. 1 also lists the transients that are considered leading indicators of fatigue usage and are monitored by the RNP B.3.19 program. For the environmentally adjusted fatigue CUF analyses, the number of load/unload transients was reduced from 29,000 cycles used in the original design to 19,000 cycles. The total transient experienced to date (April 2003) is less than 300, and the 60-year projection is approximately 600 cycles.

The reviewers noted that regarding transients monitoring, the bottom line is the licensee's need to monitor all transients that are used in the fatigue calculation, not just those transients that "contribute the most to the fatigue usage." Licensees need justification if all transients are not monitored. The reviewers noted that during RNP LRA review, the applicant had described the procedure for identifying the transients that are monitored by the Fatigue Monitoring program. The applicant stated that the transients that are counted are those most severe transients, and likely to result in fatigue cracking. For a given component, the influence of any particular transient on the CUF and the magnitude of total CUF, determine whether that particular event should be counted and tracked. First, component locations with CUF values of 0.1 or more were identified. Then the individual transients that contribute to 50 percent or more of the fatigue usage for these locations are identified. These transients are tracked by the RNP AMP B.3.19. Therefore, based on the information available on the Robinson portal and the information in the RNP LRA SER, the licensee is not monitoring all the transients included in the fatigue analysis, but monitoring only those transients that are identified as leading indicators for fatigue, using the procedure described above.

RNP also noted that in February 1994, a pressurizer transient occurred that exceeded the plant technical specification rate limit; 37.8°C/hr (100°F/hr) for heatups and 93.3°C/hr (200°F/hr) for cooldowns. A detailed evaluation of the transient was performed in WCAP-14209; the analyses included past out-of-limit transients of 16 cooldowns and 8 heatup excursions. All fatigue analyses performed for the RNP LRA review included 40 occurrences each of the two transients.

B.23 Systems Monitoring Program (LRA Section B.3.17)

Associated GALL Report AMP: **2001 GALL Report, Plant-Specific Program most closely related to XI.M36 External Surfaces Monitoring of Mechanical Components**

B.23.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The Systems Monitoring Program is credited for aging management of selected components in the various plant systems at RNP. The aging effects/mechanisms of concern are as follows: • Loss of Material due to General Corrosion • Loss of Material due to Crevice Corrosion • Loss of Material due to Pitting Corrosion • Loss of Material due to Galvanic Corrosion • Loss of Material due to MIC • Cracking due to SCC • Change in Material Properties due to Elevated Temperatures • Cracking due to Elevated Temperatures • Loss of Heat Transfer Effectiveness due to Fouling of Heat Transfer Surfaces • Change in Material Properties due to Irradiation Embrittlement • Cracking due to Irradiation Embrittlement • Loss of Material due to Aggressive Chemical Attack • Loss of Mechanical Closure Integrity due to Loss of Material due to Aggressive Chemical Attack	No significant issue or further review item was identified.
1. Scope of Program	The Systems Monitoring Program is based upon current plant activities delineated in Technical Management Procedure TMM-104, System Walkdown Procedure. Current walkdown scope includes all maintenance rule	Industry personnel were asked how the scope of this program compares to GALL, Rev.2 AMP XI.M36 "External Surfaces Monitoring of Mechanical Components" and XI.M38 "Inspection of Internal Surfaces in Miscellaneous

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	systems and additional systems listed in TMM-104, Attachment 10.1, which encompasses the License Renewal systems listed in Section 6.2 of RNP-L/LR-0640. The aging effects to be managed by the Systems Monitoring Program are listed in Section 6.2.1 of RNP-L/LR-0640. In addition to Systems Monitoring Program, TMM-104 is also credited for the Structures Monitoring Program. The TMM-104 process is augmented by System Readiness Assessments done per PLP-059. This includes an affirmation of readiness by Responsible Engineers that systems are ready to support Mode 4 and Mode 2 operations. Inaccessible systems/portions of systems, which cannot be monitored at power per TMM-104 are walked down per PLP-059 per guidance provided in TMM-104. Systems 7060, 8050, and 8060 are within the scope of License Renewal for containment isolation purposes only. The system walkdowns for the in-scope portions of these systems are done under pseudo-System 1000 (Containment Isolation Valves), which is considered a Maintenance Rule system. The components included under System 3015 are within the pressure boundaries of Systems 3050 and 3065, and will be walked down as a part of these systems.	Piping and Ducting Components." For example, both AMPs XI.36 and XI.M38 provide considerable detail on the inspection of polymeric materials, but these materials are not mentioned in this site-specific AMP. Industry personnel were asked to provide details on what components are included in Systems 7060, 8050, 8060, 3015, 3050, and 3065.
2. Preventive Actions	The Systems Monitoring Program is a condition-monitoring program; thus, there is no preventive action.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	The aging effects and mechanisms to be managed by the Systems Monitoring Program are listed in Section 6.2.1 of RNP-L/LR-0640. TMM-104 provides systems inspection guidelines in Attachment 10.3 (all components except tanks) and Attachment 10.9 (tanks). The current TMM-104 guidelines do not specifically describe aging effects described in Section 6.2.1 of RNP-L/LR-0640. (See	RNP-L/LR-0640, Section 6.5, defines "seismic continuity piping" as the non-safety related piping segment that <u>extends beyond safety related license renewal boundaries</u> and is relied upon to anchor safety related piping in establishing seismic qualification. However, EGR-NGGC-0026, Rev. 3 ("System Walkdown Procedure") states that "These piping segments are <u>in the scope of license renewal</u>

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	program enhancements below). Seismic continuity piping is credited for maintaining structural integrity of SCCs within the scope of License Renewal. Enhancements to TMM-104 will ensure seismic continuity piping is monitored. TMM-104 does not specifically require "extent of degradation" to be recorded. However, enhancements described in element 6 below will ensure that degradations will be recorded, qualified, and dispositioned as appropriate. Implementation of the System Monitoring Program with the following enhancements provides a link between the inspection guidelines and the specific components and associated degradations. The components/commodity groups and associated aging effects are assigned to Aging Management Programs during the AMR process. A link with the component intended function is established in the AMR process. Enhancements discussed below give reasonable assurance the presence of aging effects will be detected and recorded. Although the RNP AMR methodology does not specifically identify "Loss of Material due to Wear", it will be added to the checklist for consistency with GALL VII.F1.1-c, VII.F2.1-c, VII.F3.1-c, and VII.F4.1-c. Program Enhancements: 1. Revise TMM-104 Attachment(s) to specifically include aging effects described in Attachments 1 and 2 of RNP-L/LR-0640, such as loss of material due to aggressive chemical attack. In addition to these aging effects, add a program enhancement to ensure "Loss of Material due to Wear" is specifically included as an aging effect identified in the system walkdown checklist for the flexible collars between ducts and fans. Walkdowns should consider possible presence of chemical species (such as sodium	and are subject to system walkdown requirements." Industry personnel were asked if this piping is within the scope of license renewal. RNP-L/LR-0640 goes on to state that "Inasmuch as aging management of seismic continuity piping does not solely rely upon the Systems Monitoring Program, it is not necessary to apply the same rigor of inspection for seismic continuity piping/components as would be expected for safety-related piping. It is therefore assumed that the condition of seismic continuity piping at or near the connection is representative of the general condition of the connected piping up to the next credited anchor." Industry personnel were asked in what respects are the inspections of this piping less rigorous.

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	hydroxide) on the floor or equipment. 2. Revise TMM-104 Attachment 10.3 to a checklist format, to ensure that all aging effects are specifically addressed and the extent of degradation is recorded as applicable. The revised Attachment will require System Engineers to inspect connected seismic continuity piping/components, in addition to piping and components within the system(s) being walked down. 3. Revise TMM-104 to include guidance for inspecting connected piping/components. Connected (seismic continuity) piping is to be inspected as described in Section 6.5 of RNP-L/LR-0640.	
4. Detection of Aging Effects	The Systems Monitoring Program relies on visual inspection of SSCs during system walkdowns, to detect and qualify degradations. Degradations deemed to be "unacceptable" will have a condition report initiated and will be handled under the Corrective Action Program. Thus, the Systems Monitoring Program is designed to detect degradation not solely on detecting failure, but rather, on detection of aging effects prior to structure or component failure. Accessible portions of systems governed by both the maintenance rule and license renewal rule (10CFR Parts 50 and 54) are walked down (visual inspection) at least once per quarter. Walkdowns typically are scheduled and performed so the entire system is fully walked down within one operating cycle.	This implies that the inspection frequency for the system walkdowns corresponds to Robinson's 18-month (?) fuel cycle. Industry personnel were asked if any inspections are made on a more frequent basis. Program element 4 of Robinson AMP B.3.18 ("Preventive Maintenance Program") also mentions inspections as a means for detecting aging effects. Industry personnel were asked how these inspections differ from the walkdowns; under what program are non-visual inspections (e.g., EC and other NDE) performed; and how, and under what AMP are internal surfaces monitored and inspected.
5. Monitoring and Trending	Administrative controls provide instructions for monitoring systems to permit early detection of degradation. Data from walkdowns is trended and evaluated to identify and correct problems. As stated earlier, the Systems Monitoring Program will include enhancements to ensure aging indicators are quantified so that trending can be	Industry personnel were asked to provide more detail on the record keeping and processes used for trending.

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	done effectively.	
6. Acceptance Criteria	The program administrative controls will be enhanced to include visual monitoring acceptance criteria: ACC - Acceptable, AWD - Acceptable with Deficiencies, or UNA – Unacceptable, and guidelines for applying these criteria.	No significant issue or further review item was identified.
7. Corrective Actions	The program administrative controls will be enhanced to address corrective actions and to initiate a condition report for unacceptable degradation. Corrective actions including root cause determinations and prevention of recurrence are performed in accordance with the Corrective Action Program. Timeliness of corrective action is monitored and is commensurate with the level of significance of the activity.	No significant issue or further review item was identified.
8. Confirmation Process	Effectiveness of this Program (as enhanced) will be monitored using site quality assurance (QA) procedures, review and approval processes, and administrative controls which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	RNP QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50, and will continue to be adequate for the period of extended operation. LRA Commitment #28 specified that prior to the period of extended operation, the administrative controls of the existing Systems Monitoring Program will be enhanced to: (1) Include aging effects identified in the AMRs, (2) identify inspection criteria in checklist form, (3) include guidance for inspecting connected piping/components, (4) require that the extent of degradation be recorded and that appropriate corrective action(s) be taken, (5) add a section specifically addressing corrective actions, and (6)	NRC IP 71003 Inspection Report 05000261/2010008 (April 7, 2010) found that Commitment #28 had been partially completed, and that additional tasks were pending to be implemented prior to the period of extended operation. Industry personnel were asked if this commitment was completed.

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	ensure "Loss of Material due to Wear" is specifically included as an aging effect/mechanism identified in the system walkdown checklist. The first five items were included in the LRA, while the sixth item was a commitment included in the licensee's response to RAI B.3.17-1.	
10. Operating Experience	Processes at RNP are continually being upgraded based upon industry experience and research via the ongoing Operating Experience Program. The processes that comprise this aging management program have provided effective means of ensuring the system health for the systems subject to periodic walkdown. A review of condition reports and corrective actions has concluded that the Systems Engineering, including its management and administrative controls, has been the subject of continuing assessment and improvement. RNP Assessment R-ES-94-03 determined that Systems Engineers were not effectively managing system performance, and a new management team was put in place and new system walkdown procedures were developed. Self-assessment SA 94-18 was done to assess system engineering effectiveness, and CR 95-00053 was initiated as a response to a finding that system walkdowns were incomplete and not adequately documented. The plant walkdown list was replaced with a more formal procedure that included requirements ensuring that walkdowns are planned and scheduled. CR 98-00272 was initiated to address the finding that some required system walkdowns and assessment documents were not being completed and approved, as required by TMM-104, System Walkdown and Assessment Procedure. Several "program" improvements	The plant's OE suggests that there have been a number of problems in effectively implementing this program over the years. Industry personnel were asked to discuss the current state of program implementation in detail, including: (1) How long the present program owner has been in place, (2) when the System Walkdown and Assessment Procedure TMM-104 was last updated (3) when the program was last audited internally and what the findings were, (4) how Procedure TMM-104 differs from Procedure EGR-NGGC-0026 ("System Walkdown Procedure") **No action items** for consideration for SLR-GD revisions.

Program Element	Element of Licensee's AMP (LRA Section B.3.17)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	were made because of this CR. These include a revision of TMM-104 to clarify instructions to the walkdown process, and the addition of an attachment to TMM-104 for scheduling system walkdowns. Self-Assessment 16681, conducted in October 2000 found several deficiencies in the areas of data monitoring and trending, and corrective actions were implemented.	

B.23.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.23.5. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. Assessment 16681, Self-Assessment, October 2000
3. Assessment 447056 (nonpublic), Robinson Secondary Chemistry Self-Assessment, 2011.
4. CP-001, Rev. 111, Plant Operating Manual, Vol. 5, Part 3, CP-001, Chemistry Monitoring Program.
5. CR 95-0053.
6. CR 98-0272.
7. EGR-NGGC-0026 (nonpublic), Rev. 3, System Walkdown Procedure.
8. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
9. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
10. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
11. PLP-059.
12. R-ES-94-03, RNP Assessment.
13. RNP-L/LR-0600, Rev. 11, Aging Management Program, Water Chemistry Program, 2004.

14. RNP-L/LR-0640
15. SA 94-18, Self-assessment
16. TMM-104, System Walkdown Procedure.

B.23.6. Summary

The Robinson System Monitoring Program (AMP B.3.17) is an existing plant-specific AMP that is credited for aging management of selected systems, structures, and components with respect to the following aging effects:

- Loss of material due to general crevice, pitting, and galvanic corrosion and MIC
- Cracking due to SCC
- Change in material properties and cracking due to elevated temperatures
- Loss of heat transfer effectiveness due to fouling of heat transfer surfaces
- Change in material properties and cracking due to irradiation embrittlement
- Loss of Material due to aggressive chemical attack
- Loss of mechanical closure integrity due to loss of material due to aggressive chemical attack

The program appears to complement the Robinson Preventive Maintenance Program in terms of aging effects managed, but the present program is a condition-monitoring limited to visual inspections, and includes no preventive or remedial actions. The program is based on scheduled system walkdowns, system health reports, and performance monitoring and trending of systems. The system monitoring procedures are detailed in Robinson document EGR-NGGC-0026.

The LRA states that the current systems monitoring procedures do not specifically describe the aging effects identified in the AMRs, and the program was enhanced to do the following:

- Include aging effects identified in the aging management reviews
- Identify inspection criteria in checklist form
- Include guidance for inspecting connected piping/components
- Require documenting identified degradation and initiating appropriate corrective action(s)
- Add a section specifically addressing corrective actions

During the audit, the reviewers noted that several Robinson self-assessments and condition reports, prepared prior to license renewal in 2004, cited numerous deficiencies in this program, including ineffective management, inadequate documentation, failure to complete

walkdowns, and inadequate data monitoring and trending. The Robinson staff responded that the present program is significantly improved over that in place in the 1990's, particularly in terms of program procedures, record-keeping, and data monitoring and trending. In particular, a comprehensive electronic data base is maintained to track component conditions with time. All of the concerns cited above had apparently been satisfactorily addressed before license renewal in 2004, and none were cited in the SER.

The reviewers also raised a question concerning seismic continuity piping, which is inspected as a part of this program. The Robinson program evaluation document RNP-L/LR-0640, Section 6.5, defines "seismic continuity piping" as the non-safety related piping segment that *extends beyond safety related license renewal boundaries* and is relied upon to anchor safety related piping in establishing seismic qualification. However, the program procedure EGR-NGGC-0026, Rev. 3 ("System Walkdown Procedure") states that "These piping segments are *in the scope of license renewal* and are subject to system walkdown requirements." Robinson clarified that the seismic continuity piping in question is, in fact, within the scope of license renewal.

The program deficiencies identified in the Robinson self-assessments and condition reports conducted prior to license renewal appear to have been satisfactorily addressed, based on the results of the license renewal process in 2004, and no significant issues were identified in the present program during the audit.

B.24 Preventive Maintenance Program (LRA Section B.3.18)

Associated GALL Report AMP: **2001 GALL Report, Plant-Specific Program most closely related to XI.M36 External Surfaces Monitoring of Mechanical Components, and XI.M38 Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components**

B.24.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.18)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The Preventive Maintenance Program is credited for aging management of selected components in the various plant systems at RNP. The aging effects/mechanisms of concern are as follows: • Change in Material Properties due to Elevated Temperature • Change in Material Properties due to Irradiation Embrittlement • Change in Material Properties due to Ultraviolet Radiation and Ozone Exposure • Change in Material Properties due to Various Degradation Mechanisms • Cracking due to Elevated Temperature • Cracking due to Irradiation Embrittlement • Cracking due to SCC • Cracking due to Ultraviolet Radiation and Ozone Exposure • Cracking due to Various Degradation Mechanisms • Loss of Material due to Crevice Corrosion • Loss of Material due to Erosion • Loss of Material due to FAC • Loss of Material due to Galvanic Corrosion • Loss of Material due to General Corrosion • Loss of Material due to MIC	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.18)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	• Loss of Material due to Pitting Corrosion • Loss of Material due to Various Degradation Mechanisms • Loss of Pre-load due to Stress Relaxation • Reduced Insulation Resistance due to Thermal Embrittlement • Loss of Material due to Aggressive Chemical Attack • Loss of Heat Transfer due to Fouling of Heat Transfer Surfaces	
1. Scope of Program	The PM Program assures that various aging effects are managed for a wide range of components. Although not part of the site maintenance procedures, the PM Program includes activities performed during operations rounds and periodic operation of equipment, such as monitoring filter differential pressures and purging water from air receivers. This element will be enhanced to incorporate specific aging management activities identified in the aging management reviews into the program.	Industry personnel were asked how the scope of this program compares to GALL, Rev.2 AMP XI.M36 "External Surfaces Monitoring of Mechanical Components" and XI.M38 "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components" For example, both AMPs XI.36 and XI.M38 provide considerable detail on the inspection of polymeric materials, but these materials are not mentioned in this site-specific AMP.
2. Preventive Actions	The PM Program includes periodic refurbishment or replacement of components, which could be considered preventive or mitigative actions. The inspections and testing activities used to identify component aging degradation effects do not constitute preventive actions in the context of this element. However, they are consistent with a monitoring approach to aging management.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	The administrative controls that govern the PM Program provide instructions for monitoring structures, systems, and components, to permit early detection of degradation. Inspection and testing activities monitor various parameters, including surface condition, loss of material, presence of corrosion products, and signs of cracking. The current guidelines in operations, maintenance and surveillance test procedures and Model Work Orders may not specifically describe the aging effects applicable to	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.18)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	LR. These documents will be enhanced, as necessary, to include aging effects/mechanisms identified in the aging management reviews into the PM Program.	
4. Detection of Aging Effects	PM activities provide for periodic component replacement, inspections, and testing to detect aging effects and mechanisms. The extent and schedule of the inspections and testing assures detection of component degradation, prior to the loss of their intended functions. Established techniques such as visual inspections are used. The PM Program controlling documents promote activities that are aimed at PM optimization and continual improvement. This includes evaluation of frequency and appropriateness of PMs, to assess the effectiveness, and to compare with typical industry practices.	Program element 4 of Robinson AMP B.3.17 ("Systems Monitoring Program") also mentions visual inspections during system walkdowns as a means for detecting aging effects. Industry personnel were asked how these inspections differ from the walkdowns referred to, and under what program are non-visual inspections (e.g., UT, EC and other NDE) performed.
5. Monitoring and Trending	PM activities provide for monitoring and trending of aging degradation. Inspection intervals are established such that they provide for timely detection of component degradation. Inspection intervals are dependent on the component material and environment, and take into consideration industry and plant-specific operating experience and manufacturers recommendations. The PM Program administrative controls reference activities for monitoring structures, systems, and components, to permit early detection of degradation. Data from walkdowns are trended and evaluated to identify and correct problems. An example of technique and parameters monitored and trended is visual examinations for coating failures, corrosion, cracking, erosion, leaking and physical condition, mechanical damage, loose or missing hardware, etc. As part of the conduct of maintenance at RNP, emphasis is placed on the responsibility of all station personnel to report equipment deficiencies on a Maintenance Work Request/Work Order or via the corrective action program. As stated above, the	Describe the record-keeping and analysis processes used for trending in more detail. Auditors noted that Self-Assessment 16681, conducted in October 2000, identified problems with monitoring and trending activities under the Systems Monitoring Program, B3.17.

Program Element	Element of Licensee's AMP (LRA Section B.3.18)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Preventive Maintenance Program ensures aging indicators are trended.	
6. Acceptance Criteria	PM Program acceptance criteria are defined in the specific inspection and testing procedures. They confirm component integrity by verifying the absence of the aging effect or by comparing applicable parameters to limits, based on the applicable intended function(s), as established by the plant design basis. Degradations deemed to be unacceptable will have a condition report initiated, and will be handled under the corrective action program.	No significant issue or further review item was identified.
7. Corrective Actions	Identified deviations are evaluated within the corrective action process, which includes provisions for root cause determinations and corrective actions to prevent recurrence, as dictated by the significance of the deviation. The corrective action process is in accordance with 10 CFR 50 Appendix B.	No significant issue or further review item was identified.
8. Confirmation Process	The corrective action process is in accordance with 10 CFR 50 Appendix B and includes (1) reviews to assure that proposed actions are adequate, (2) tracking and reporting of open corrective actions, and (3) reviews of corrective action effectiveness for root cause determinations.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	The review and approval process for procedures, procedure changes, and the identification of maintenance activities that require maintenance procedures or instructions, are described in formal plant administrative controls. RNP QA procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50, and will continue to be adequate for the period of extended operation.	N/A – this is boilerplate and items of concern are not expected for this element.

Program Element	Element of Licensee's AMP (LRA Section B.3.18)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
10. Operating Experience	Periodic surveillance and preventive maintenance activities have been in place at RNP since the plant began operation. These activities have proven effective at maintaining the material condition of systems, structures, and components, and detecting unsatisfactory conditions. There is a demonstrated history of detecting damaged and degraded components, causing their repair or replacement in accordance with the site corrective action process. The Preventive Maintenance and Surveillance Test Administration procedure describes the process used to ensure continuous improvement in the implementation of its governed processes. These activities, along with the requirements for self-assessments and periodic assessments, provide reasonable assurance that the Preventive Maintenance Program will continue to perform in an effective manner.	No significant issue or further review item was identified.

B.24.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.24.5. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. 10 CFR 50.65, Maintenance Rule.
3. ADM-NGGC-0203, Rev. 18, Preventive Maintenance and Surveillance Testing Administration.
4. Assessment 16681, Self-Assessment, October 2000
5. Assessment 572847, Robinson Self-Assessment, November 26 – 28, 2012
6. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.

7. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
8. RNP-L/LR-0642, Rev. 10, Aging Management Program, Preventive Maintenance Program.

B.24.6. Summary

The Robinson Preventive Maintenance Program (AMP B3.18) is an existing plant-specific program that is credited for aging management of selected components in the various plant systems at Robinson. The program is used to prevent or minimize equipment breakdown and to maintain equipment in a satisfactory condition for normal and/or emergency use. The program consists of periodic inspections, test, and component replacement as necessary to manage various aging effects/mechanisms, including changes in material properties, cracking, loss of material, loss of bolting preload due to stress relaxation, reduced insulation resistance due to thermal embrittlement, and loss of heat transfer due to fouling. In the SER, the applicant stated that the purpose of the Preventive Maintenance Program is to assure that various aging effects are managed for a wide range of components. In the LRA, Robinson stated that the “Scope of Program” element would be enhanced to incorporate specific aging management activities identified in the license renewal aging management reviews into the program.

The SER states that the activities performed under the Preventive Maintenance Program can be described in the general categories of component inspections for degradation such as loss of material, cracking and change in material properties, monitoring filter differential pressure, purging water from air receivers, checking bolt tension for loss of preload, checking for pressure boundary leakage in valves, piping and fittings, visual inspection and monitoring of cables and connections for loss of coating on cable trays or loss of insulation. The program administrative controls reference activities for monitoring structures, systems, and components to permit early detection of degradation. Data from walkdowns are trended and evaluated to identify and correct problems. In addition, the program includes periodic refurbishment or replacement of components.

During the audit, Robinson personnel stated that the Preventive Maintenance Program is driven by 10 CFR 50.65 (“Maintenance Rule”), as applied to passive components. They also stated that, in addition to the inspections and monitoring activities described in the SER, the program also includes NDE techniques such as UT and EC techniques to assess component conditions. They added that the maintenance activities are “task driven, rather than frequency driven” and that maintenance frequencies are adjusted based on plant operating experience. Component condition monitoring and trending comprise an important element of the program. Occasional minor component accessibility issues were noted, but these were not considered significant.

The Robinson personnel also stated that the Preventive Maintenance Program is also an implementation program, in that it addresses and corrects deficiencies noted under other condition-monitoring AMPs. The example was cited, in which water contamination of diesel fuel oil, identified under the Fuel Oil Chemistry Program, would be corrected under the Preventive Maintenance Program.

The Robinson Self-Assessment Number 572847 of November 26 – 28, 2012 notes the following with respect to the LR commitments for the Preventive Maintenance Program:

> *"The commitments within the preventive maintenance program are properly implemented and designated as committed items. Because these activities span approximately 44 systems, there is no one point of ownership for the results of the PM activities that are performed. This may result in missed opportunities to identify aging effects across system boundaries. It is recommended that a recurring task be assigned to the License Renewal Program Engineer to periodically review completed PM activities that are credited for license renewal."*

This self-assessment recommended the creation of a recurring task for the License Renewal Program Engineer, to periodically review completed preventive maintenance activities that are credited for license renewal, to identify potential aging effects across system boundaries. The breadth of the Preventive Maintenance Program, and the potential challenges in identifying and addressing aging effects, were also noted during the audit, but no specific issues were identified.

B.25 ASME Section XI, Subsection IWE (LRA Section B.3.13)

Associated GALL Report AMP: **2001 GALL Report, XI.S1 ASME Section XI, Subsection IWE**

B.25.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The ASME Section XI, Subsection IWE program consists of periodic visual, surface, and volumetric inspection of steel containment components, for signs of degradation, assessment of damage, and corrective actions. As a result of the license renewal review, the administrative controls associated with program element, Confirmation Process, for the program will be enhanced to (a) specify the requirements for conducting reexaminations, and (b) document that repairs meet the specified acceptance standards.	No significant issue or further review item was identified.
1. Scope of Program	The RNP program includes Class MC pressure-retaining components and their integral attachments; metallic shell and penetration liners of Class CC pressure retaining components and their integral attachments; containment pressure-retaining bolting; and metal containment surface areas, including welds and base metal. The program and the 10 CFR 50 Appendix J Program manage aging effects on the containment pressure boundary components. The inaccessible portions of the containment liner and the moisture barrier inside the containment, at the liner plate/floor concrete interface, are inspected by the One-Time Inspection Program.	No significant issue or further review item was identified.
2. Preventive Actions	No preventive actions are specified; Subsection IWE is a monitoring program.	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
3. Parameters Monitored/ Inspected	Parameters Monitored/ Inspected include: • Loss of Material due to General Corrosion • Loss of Material due to Galvanic Corrosion • Loss of Material due to Aggressive Chemical Attack • Loss of Material due to Crevice Corrosion • Loss of Material due to Pitting Corrosion • Change in Material Properties due to Elevated Temperature • Cracking due to Elevated Temperature • Cracking due to Thermal Fatigue Bellows – the carbon steel endplates inside the containment are managed for loss of material from galvanic corrosion and general corrosion. Containment liner plate – the liner plate below elevation 228' is managed for loss of material from aggressive chemical attack, from crevice corrosion and pitting corrosion, due to the corrosive water, which potentially penetrates the construction joint and the moisture barrier to the embedded liner plate.	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): 1. The LRA identified penetration bellows with an aging effect/mechanism of loss of material, due to galvanic corrosion. GALL does not provide an item for penetration bellows with an aging effect/mechanism of loss of material, due to galvanic corrosion. It is recommended to include this item in GALL.
4. Detection of Aging Effects	Inservice examinations and pressure tests are performed in accordance with Inspection Program B, as described in IWE-2412. Under Inspection Program B, the first Containment Inspection Interval at RNP is effective from September 9, 1998 to September 8, 2008 for Subsection IWE activities. As required by Table IWE-2412-1, 100% of the total interval inspections are required by the end of 10 years (the end of the third period is 10 years at RNP). After 40 years of operation, any future examinations comply with the requirements of Inspection Program B as described in ASME IWE-2412.	1. SER states that the staff reviewed this response in conjunction with the applicable relief request and the responses provided to RAls 3.5.1 -7 and 3.5.1-19. Based on these reviews, the staff determined that: (a) By the 2005 outage, the applicant will perform a focused inspection of the liner plate behind the moisture barrier, and the insulation at the junction of the wall and the concrete, at elevation 228 ft. (b) The applicant will perform the periodic examination of these areas, as required by 10 CFR 50.55a and Subsection IWE (c) As a result of the inspection performed in 2005, if additional inspections are required, the applicant will determine the time and schedule of the additional

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		examinations. The applicant stated that the moisture barrier between the containment liner and concrete floor at elevation 228 feet is included in the IWE program to be inspected whenever the containment liner insulation is removed for maintenance work. (a) Industry personnel discussed the results of the inspection performed in 2005 and any additional inspection after 2005. (b) Industry personnel discussed the inspection frequency for the maintenance work that enables inspection of the moisture barrier between the containment liner and concrete floor at elevation 228 feet. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Provide guidance in GALL about inspecting elements in contact with chloride insulation, based on some sampling method. ***Technical Basis*:** Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the liner coating degradation, and subsequent corrosion of the liner. Corrosion of containment penetrations also occurred in RNP, due to leaching of chloride in the piping insulation.
5. Monitoring and Trending	All accessible surfaces are monitored, by virtue of the examination requirements, on a scheduled basis. The components, items, and areas, subject to the requirements of Subsection IWE, are uniquely identified for tracking the required examinations and/or test completion.	SER Section 3.5.2.2.1.5 states that the applicant has a commitment to perform structural integrity testing (SIT) and making the necessary observations for the integrity for the RNP containment during the tests. The containment SIT test would detect degradation of the containment pressure boundary components and liner. Industry personnel were asked to verify the results of SIT.
6. Acceptance Criteria	For some examinations, numerical values are specified for the acceptance standards for RNP. For the containment	No significant issue or further review item was identified. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs**

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	steel liner base metal, a numerical value in EST-150 for liner plate base metal degradation is specified. For liner plate degradation that has reduced thickness by greater than 10% or below the minimum design thickness, specified by an engineering evaluation, EST-150 requires an approved plant process to be accepted by an engineering evaluation or to take corrective action.	(as result of audit): It is recommended to develop clear guidance in GALL on the acceptance criteria for degradation below 10 percent of the nominal wall thickness, and when areas should or should not be recoated.
7. Corrective Actions	Components that do not meet the acceptance standards, and are not accepted by an engineering evaluation, are repaired or replaced to the extent necessary to meet the acceptance standards of IWE-3000.	No significant issue or further review item was identified.
8. Confirmation Process	The plant procedure TMM-124 is enhanced to add the following statement: "Reexaminations are conducted in accordance with the requirements of IWA-2200, and the recorded results are to demonstrate that the repair meets the acceptance standards set forth in Table IWE-3410-1. It is consistent with GALL.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	Consistent with GALL	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The RNP operation experience includes: • Corrosion was identified on the inside vertical face of the equipment hatch cylinder. The insulation was removed at the low point of the equipment hatch; the equipment hatch was inspected and recoated as necessary. • Based on the discovery of degraded protective insulation sheathing on the containment liner, administrative controls were upgraded to require a visual inspection of accessible interior and exterior surfaces of Containment Structures and components for evidence of deterioration. • A steam generator blowdown penetration bellows failed	1. In RNP One-Time Inspection Summary Report, it states that: Certain inaccessible areas of the containment liner plate and containment structure moisture barrier are required to be inspected to determine their material condition. During RO-22, EC-52368, "Access and inspection of CV Liner at Regenerative Heat Exchanger and Refueling Canal" was implemented. This EC removed the sheathing and insulation so that the IWE moisture barrier and CV liner areas behind the insulation could be examined. Although only a portion of the barrier was degraded, the moisture barrier was removed at each of the panel locations and

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	due to a crack caused by TGSCC. Modifications were made to eliminate the aging mechanism, including replacement of the penetration insulation with chloride free insulation. • Instances of containment liner corrosion have been identified. These areas include the containment liner plate at elevation 228 feet and the containment liner plate beneath the concrete floor below 228 feet. The corrosion is caused by leakage of borated water. The affected areas have been evaluated, and meet minimum wall thickness. • Recent inspections identified that boric acid leakage has penetrated the epoxy construction joint seal near the ECCS sump. The watertight seal material at the ECCS Sump has cracked or separated from the adjacent concrete and permitted the borated water to migrate around the first level CV floor. There is the potential that borated water could cause corrosion of the carbon steel rebar. • Localized bulging of the containment liner. The bulge in the RNP containment liner was analyzed in the "HB Robinson Unit No. 2 Containment Liner Stress Analysis Report," dated June 21, 1974. The bulge is believed to have been present since initial construction. A strain-monitoring program was initiated for one cycle, which indicated no gross movement or growth of the liner. Two additional bulged liner areas were discovered in 1992. These areas are also believed to have existed since initial construction. These bulges were monitored in 1993 with negligible movement and were considered stable and acceptable, with no further monitoring required. • In the NRC IR 2010008, it states that the inspectors reviewed a sample of engineering evaluations for the	replaced. Because degradation was found in the One-Time Inspection of inaccessible areas of the containment liner plate and containment structure moisture barrier, verify the aging management activities for these items during the period of extended operation such as intervals for future inspection. 2. SER: Sec. 3.5.2.2.1.4 states: A section of the liner was examined below the concrete floor at the 228 foot elevation. A visual examination determined there were tightly adhered corrosion products on the liner surface. Water samples located in this void area were alkaline, stagnant, low re-oxygenation, low chloride concentration, and low boron concentration. The vertical liner below the concrete floor was in better condition and less pitted than the liner surface immediately above the concrete floor. The liner surface immediately above the concrete floor had pitting corrosion up to 0.1875 inch, which was the worst case. This corrosion rate was estimated, based on the worst-case degradation occurring from the containment flooding event in 1975 to the liner inspections in 1998 (0.1875 inch in 23 years). The corrosion rate was then applied to the difference between the actual thickness examined for the liner and minimum design thickness. The worst-case corrosion area above the concrete was determined to conservatively meet the liner design thickness until year 2005. The liner plate thickness below the concrete, which had no degradation, was determined to be acceptable (exceeding the minimum wall thickness) for continued service until 2005. By 2005, either further evaluation or inspection will be required for the inaccessible portion of the liner below the concrete. Because the minimum wall thickness for the liner is

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	metal containment liner thickness and ensured that any areas of less than the minimum required thickness were properly dispositioned and repaired, if necessary.	reached in 2005, verify what actions (further evaluation or inspection) shall be taken after 2005 and during the period of extended operation, such as time and schedule of any planned future inspections. 3. LRA Table 3.5-1 line item 2 states that: The sole occurrence of SCC on penetration bellows at RNP involved a stainless steel bellows exposed to chlorides. This was corrected by changes to the penetration design, and by replacing the piping insulation with a chloride-free type. The SER also states that a Steam Generator Blowdown bellows failed due to a crack caused by TGSCC. Condensation of water from the penetration pressurization system supplied air inside the penetration, wetted the pipe insulation, and transported the chlorides contained in the insulation materials to the penetration bellows. The presence of the chlorides on the SS material of the bellows caused the bellows to fail. The insulation was replaced with chloride free insulation. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): It is recommended to add this OE to GALL (i.e, chlorides contained in the piping insulation materials causing failure of penetration bellows). 4. Recent RNP inspections identified the potential that boric acid leakage has penetrated the epoxy construction joint seal near the ECCS sump. Verify the corrective actions and the plan for any future inspection for this issue. 5. On the bulging in the RNP containment liner, the SER states that based on the observations made by the applicant during subsequent pressure tests and inspections, the staff concluded that such bulging will not be detrimental to the containment function during the period of extended operation. However, the staff recommends monitoring of such liner plate bulges during subsequent

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		inspections performed under this program. Verify the results of the subsequent inspections, as recommended by NRC staff and associated plant procedures. 6. The AMP basis document (RNP-L/LR-0616) addresses many CRs. However, most of CRs occurred at least 10 years ago. Verify the CRs in the last 5 years for any aging related issues. 7. NRC issued IN 2011-15, "Steel Containment Degradation and Associated License Renewal Aging Management Issues," on the recent issues identified concerning degradation of steel containment that could impact aging management of containment structures during the period of extended operation. The IN describes the problems found in recent inspections of steel containments in the Cooper, Hope Creek, and Dresden plants. NRC also issued IN 2010-12, "Containment Liner Corrosion," addressing corrosion of steel containment liners of the Beaver Valley, Salem, and Brunswick plants. Verify the RNP program has or will consider these two INs in the OE of the program 8. The IWE and IWL System Health Report (7/1/2012-9/30/2012) states that: Indicator of Industry Contact: "Establish industry contacts with ASME Code committee representatives, peers at other nuclear utilities, and outside consultants as necessary to ensure that inspection, examination and testing programs properly utilize external operating experience." The report indicates that there are no formal groups other than the ASME code committee, and no active involvement within industry in past year or no active sharing across

Program Element	Element of Licensee's AMP (LRA Section B.3.13)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		sites. This indicator is being identified as "Yellow". Verify any resolution or improvement of this indicator. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): It is recommended to add these highlighted above INs to GALL-SLR.

B.25.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.25.5. Documents Reviewed during the Audit

1. CM-764, Rev. 13, Inspection and Repair of CV Liner and Insulation.
2. EC 72699, Evaluation of Containment Building Liner, Insulation, Sheathing, and Coatings
3. EGR-NGGC-0015, Rev. 4, Containment Inspection Program
4. EGR-NGGC-0211, Rev. 0, ASME Section XI Repair/Replacement Program
5. IN 2010-12, Containment Liner Corrosion.
6. IN 2011-15, Steel Containment Degradation and Associated License Renewal Aging Management Issues.
7. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
8. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
9. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
10. One-Time Inspection Summary Report (Doc. 66 in RNP License Renewal Portal)
11. Program Health Report, Rev. 3, IWE IWL Program (7/1/2012- 9/30/2012)
12. RNP, Containment Liner Stress Analysis Report, June 21, 1974
13. RNP-L/LR-0616, Rev. 2, Aging Management Program, ASME Section XI, Subsection IWE, June 22, 2009
14. TMM-124, Rev. 11, Inservice IWE/IWL Program

B.25.6. Summary

Robinson implements GALL Report AMP XI.S1 ASME Section XI, Subsection IWE through its existing AMP B3.13, “ASME Section XI, Subsection IWE.” The program consists of periodic visual, surface, and volumetric inspection of steel containment components for signs of degradation, assessment of damage, and corrective actions. The program has two enhancements that include (1) specifying the requirements for conducting reexaminations, and (2) documenting the repairs that meet the specified acceptance standards.

The RNP program and the 10 CFR 50 Appendix J Program manage aging effects of the containment pressure boundary components. The parameters monitored/ inspected of concern in the program include:

- Loss of Material due to General Corrosion
- Loss of Material due to Galvanic Corrosion
- Loss of Material due to Aggressive Chemical Attack
- Loss of Material due to Crevice Corrosion
- Loss of Material due to Pitting Corrosion
- Change in Material Properties due to Elevated Temperature
- Cracking due to Elevated Temperature
- Cracking due to Thermal Fatigue

The RNP containment liner is inaccessible. The liner is covered by insulation and sheathing panels with caulked joints. RNP committed to remove the sheathing and insulation from the bottom row 360° around the containment, to examine the liner surface and the moisture barrier between the concrete and the liner over the duration of the Second Ten Year Examinations. In addition, anytime a sheathing/insulation panel is removed from the containment liner, all the required ASME IWE examinations will be performed.

The inaccessible portion of the containment liner and moisture barrier at the liner/containment floor interface was inspected by the RNP One-Time Inspection Program in 2005 with the insulation removed. The results indicated that the liner is acceptable until 2023 at the worst corrosion rate. Since 2005, RNP has continued to remove the lower row of panels during each IWE inspection period to replace the moisture barrier completely. RNP also implemented a separate liner restoration process, which removes and replaces the existing insulation panels with chloride-free insulation during each outage.

In 2012, 136 insulation and sheathing panels (about ~6% of the total panels) were removed to inspect the liner. Corrosion and bulge were observed at some areas. Engineering analysis indicated that there is no adverse effect on the ability of the liner plate to perform its intended function as a leak tight membrane. After the inspection, all areas of the metallic liner where corrosion was observed have been refurbished and reinstalled to conform to the original design requirements. The severity of the liner corrosion recorded during the 2012 inspection was similar to the previously evaluated corrosion dating back to 1993. The RNP engineering analysis (EC72699, ”Evaluation of Containment Building Liner, Insulation, Sheathing, and Coatings”) determined that the metallic liner corrosion is at a relatively steady state, based on the historical data.

The 2012 inspection revealed that the liner coating is less effective at locations where severe corrosion was found. Presence of moisture behind the liner insulation panels and long-term leaching of chloride from the insulation panels are the two major factors contributed to the coating degradation and subsequent corrosion of the liner. An engineering analysis is currently being performed by RNP to evaluate the possibility of maintaining the containment liner without the insulation and sheathing panels. This would enhance the accessibility of the liner and its long-term performance, if it is proven that the liner is capable of performing its intended function without the insulation and sheathing panels.

Other topics noted in the audit include:

The program is implemented through the following procedures:

EGR-NGGC-0015 Containment Inspection Program Revision 4
TMM-124 Inservice IWE/IWL Program Revision 11
CM-764 Inspection and Repair of CV Liner and Insulation Revision 13
EGR-NGGC-0211 ASME Section XI Repair/Replacement Program Revision 0

The RNP LRA identified galvanic corrosion as an aging mechanism for the containment penetration bellows. GALL does not list galvanic corrosion as an aging mechanism for the containment penetration bellows.

The program identified operating experience with corrosion of penetrations due to chlorides contained in the insulation of the piping. The penetrations were repaired as necessary, and the insulation was replaced with chloride-free insulation.

The welds between the carbon steel liner and the carbon steel penetration is contained in the IWE Program, and are examined under the IWE Program.

The staff noted operating experience with corrosion of steel and stainless steel elements due to insulation containing chlorides. It is recommended that the GALL Report add a discussion of replacing or removing insulation containing chlorides in the preventive measures

and operating experience elements of the AMP (or possibly as a further evaluation section in Section 3.5 of the SRP-LR). At a minimum, guidance should be provided about inspecting elements in contact with chloride insulation, based on some sampling method.

The staff noted that the ASME Section XI, Subsection IWE currently allows for owner defined acceptance criteria for degradation below 10 percent of the nominal wall thickness. This has led to confusion about how this criteria should be applied (general area or local degradation), as well as what is acceptable for degradation below 10 percent. There is also no clear discussion about when degraded areas should be coated and how this action affects future inspections or acceptance. It is recommended to develop clear guidance in GALL on the acceptance criteria, and when areas should or should not be recoated.

Overall, the RNP ASME Section XI, Subsections IWE program appears effective. All areas of the metallic liner where corrosion was observed have been refurbished and reinstalled, to conform to the original design requirements. RNP also implemented a process, which removes and replaces the existing insulation panels with chloride-free insulation. The RNP program, as implemented, would meet the majority of GALL Revision 2 recommendations, because it addresses the moisture barrier and follows the guidance in the ASME code for inspections of the other portions of the liner. The current program may not meet all of the recommendations in the GALL Revision 2 program regarding inspection of high-strength bolts.

B.26 ASME Section XI, Subsection IWL (LRA Section B.3.14)

Associated GALL Report AMP: **2001 GALL Report, XI.S2 ASME Section XI, Subsection IWL**

B.26.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The program consists of periodic visual inspection of concrete surfaces of the RNP containment for signs of degradation, assessment of damage and corrective actions. The RNP prestressing tendons are grouted in place. Therefore, ASME Section XI Subsection IWL rules regarding unbonded post-tensioning systems are not applicable. Prior to the period of extended operation, enhancements will be made to administrative controls to require supervisors to notify Civil/Structural Design Engineering of the location, and extent of, proposed excavations of foundation concrete, and to require Civil/Structural Design Engineering to examine representative sample areas of below grade concrete, when excavated for any reason.	No significant issue or further review item was identified.
1. Scope of Program	The RNP prestressing tendons are grouted in place. The tendons are considered bonded since they are encased in grout, sealed within sleeves, and embedded in structural concrete. The tendons are permanently inaccessible. Therefore ASME Section XI, Subsection IWL rules regarding unbonded post-tensioning systems are not applicable. As a program enhancement, examination of representative samples of below-grade concrete, when excavated for any reason, will be included as part of the ASME Section XI, Subsection IWL Program.	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
2. Preventive Actions	A coating program is not currently credited for managing the effects of aging of concrete surfaces. A coating program will not be credited during the period of extended operation.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	Parameters Monitored/ Inspected include: • Change in material properties due to aggressive chemical attack • Loss of Material due to Aggressive Chemical Attack • Loss of Material due to Corrosion of Embedded Steel • Change in Material Properties due to Fatigue • Cracking due to Fatigue	No significant issue or further review item was identified.
4. Detection of Aging Effects	RNP groundwater values for chlorides and sulfates are much less than the threshold values necessary for aggressive chemical attack. However, the aging mechanisms associated with aggressive chemical attack and corrosion of embedded steel are potentially applicable to below-grade concrete structures, due to acidic groundwater. Groundwater pH has a measured range of 3.7 to 6.0 (average of 4.4). RNP will enhance the inspection requirements, to apply a special inspection provision for monitoring aging effects potentially caused by aggressive chemical attack and corrosion of embedded steel. This involves inspecting the condition of below grade concrete that is exposed during excavation. The RNP prestressing tendons are grouted in place. Therefore, ASME Section XI, Subsection IWL rules regarding unbonded post-tensioning systems are not applicable.	1. The SER states: Based on long-term monitoring from 1975 to 1995, the environmental parameters for lake water at the RNP intake structure are: - 3.14 ppm average chloride concentration - 3.67 ppm average sulfate concentration - 5.46 average pH Based on semi-annual ground water monitoring required by the State of South Carolina, the environmental parameters of Well #4 are: - No data available for chloride concentration - 21.0 ppm sulfate concentration - 4.41 ground water pH The SER states that both RNP ground water and lake water is considered aggressive because of the low pH values. The AMP base document (RNP-L/LR0617) states: "Periodic monitoring (semi-annual) of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive."

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		<u>ACTION ITEM</u> for Consideration for writing SLR-GDs (as result of audit): It is recommended to add this OE to GALL. GALL states that: In general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. It is recommended to increase the frequency of ground water sampling in GALL from "not to exceed 5 years" to "semi-annual" or "quarterly," to capture potential seasonal variations, such as winter salting. 2 The RNP is one of the few operating plants in which the containment prestressing tendons are protected from corrosion by means of cement grout. Though the cement grout provides a reliable alkaline medium for protecting the tendons, the tendon system cannot be monitored for either the remaining prestress level, or for the effectiveness of the cement grout in protecting the tendons. 1) Verify the aging management and inspection results of the protective cement grout. 2) It is recommended to include grouted tendon system in the GALL IWL AMP. 3. The RNP containment is a steel-lined concrete shell. The dome and base are constructed of reinforced concrete. The cylinder walls are concrete, reinforced circumferentially and prestressed vertically. SER Section 3.5.2.2.1.5 states that the applicant has a commitment to perform structural integrity testing (SIT) and making the necessary observations, such as horizontal concrete cracks, for the integrity for prestress tendons during the tests. Verify the results of the SIT. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): It is recommended to include guidance on aging management of containment with grouted tendon system in the GALL IWL AMP. This could be accomplished

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		by incorporating the guidance in Regulatory Guide 1.90, "Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons," Rev. 2 into the GALL Report. RG 1.90 recommends installing stress monitoring instrumentation during construction, or conducting periodic pressure testing.
5. Monitoring and Trending	The RNP prestressing tendons are grouted in place. Therefore, ASME Section XI Subsection IWL rules, regarding unbounded, post-tensioning systems are not applicable. All accessible concrete surfaces are monitored on a regular basis. The expedited examination was completed at RNP by September 9, 2001. The current schedule for the IWL examinations is to complete the second five year examinations between 9-9-2001 and 9-8-2006. Subsequent examinations are performed at 5 year intervals following the expedited examination. The frequency and scope of examination of accessible areas are sufficient to ensure that the aging effects are detected, before the design basis requirements would be compromised.	1. Verify the inspection results of the subsequent examinations after 9-8-2006. 2. Verify trending of ground water chemistry in last five years.
6. Acceptance Criteria	The concrete surfaces acceptance criteria are based on IWL-3000. It is consistent with GALL. The IWL responsible engineer is required to be a registered professional engineer, to be qualified in accordance with RNP Engineering Support Personnel (ESP) Job Specific Training Guides.	No significant issue or further review item was identified.
7. Corrective Actions	RNP plant procedure specifies: If the inservice examination results do not meet the acceptance standards established by the responsible engineer, the component shall not be returned to service, until an engineering evaluation is performed with the information listed below:	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	• The cause of the condition that does not meet the acceptance standards • If a repair is not required, the acceptability of the concrete containment without repair of the component • If a repair is required, the extent, method, and completion date of the repair must be specified • Determination if a leakage test is required • Extent, nature, and frequency of additional examinations (if required)	
8. Confirmation Process	The plant procedure EGR-NGGC-0015 provides actions for resolving unacceptable inservice results based on IWL-3300. These actions consist of preparing an engineering evaluation, which includes the extent, nature, and frequency of additional examinations, if required.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	The schedules for examinations are specified in "First Ten Year Inservice Inspection IWE/IWL Program" described in plant procedure TMM-124. Inservice inspection summary reports are prepared in accordance with IWA-6230 and include the information required by 10 CFR 50.55a(b)(2)(ix)(A), and 10 CFR 50.55a(b)(2)(ix)(D), if applicable.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The plant procedure TMM-124 currently comprises the "First Containment Inspection Interval" effective from September 9, 1998 to September 8, 2008. This time frame includes the first and second five year examinations required by Subsection IWL. Previous inspections were conducted in accordance with 10 CFR 50 Appendix J (TMM-005) and the Maintenance Rule Inspection Program (EGR-NGGC-0351 and TMM-104). Maintenance Rule baseline inspections of the containment were completed in the fall of 1996. The inspections performed under these programs were previously documented and evaluated for any degraded conditions associated with the containment	1. The AMP base document (RNP-L/LR0617) states: Recent industry operating experience (2001) has been reviewed for applicability. No industry experience was determined to affect the IWL Program since April 2000. Subsequent operating experience will be captured through the normal operating experience review process Verify any subsequent operating experience captured in the program since 2001. 2. In RNP One-Time Inspection Summary Report, it states that: Certain inaccessible areas of the containment liner plate and containment structure moisture barrier are required to

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	leak tight barrier. The RNP operation experience include: - Degraded conditions in the containment structure concrete components for the North and South Cable Vault Rooms were observed. Staining, cracking, exposed aggregate, and spalling were identified. The indications were characterized as minor, and no signs of corrosion in the cracks were noted. - An evaluation concluded that not providing cooling to the penetrations with hot piping does not degrade the concrete. Degradation has not occurred and does not require augmented examinations. - Inspection of the exterior surface of the containment dome concrete revealed accelerated degradation of the grout covering in December of 1984. A work package was issued to repair this degradation and specified that an elastomeric coating system be applied after the grout was stripped and resurfaced. The evaluation indicated that grout deterioration did not affect the structural integrity of the associated concrete. - Inspections of surveillance block tendons: The surveillance tendons consist of six 1-3/8 inch diameter bars grouted in a six-inch pipe sheath with anchor plates and prestressing-hardware, which is identical to the service tendon, except for the length. They are embedded in a section of concrete approximating the same environment as that of the service tendons. The surveillance blocks were placed next to the containment, to subject them to a similar unsheltered outdoor environment. The surveillance block tendons were inspected at 5- and 25-year intervals. The conclusions for both the 5- and 25-year surveillance blocks indicate there is no significant	be inspected to determine their material condition. During RO-22, EC-52368, "Access and inspection of CV Liner at Regenerative Heat Exchanger and Refueling Canal" was implemented. This EC removed the sheathing and insulation, so that the IWE moisture barrier and CV liner areas behind the insulation could be examined. Although only a portion of the barrier was degraded, the moisture barrier was removed at each of the panel locations and replaced. Because degradation was found in the One-Time Inspection of inaccessible areas of the containment liner plate and containment structure moisture barrier, verify the aging management activities for these items during the period of extended operation, such as intervals for future inspection. 3. Inspections of surveillance block tendons have been performed at 5- and 25-yr intervals. Verify will the surveillance block tendons be inspected again. If not re-inspected, provide the basis. 4. NRC issued IN 2010-14, Containment Concrete Surface Condition Examination Frequency and Acceptance. Verify the applicant has considered or will consider IN 2010-14 in the program. 5. The IWE and IWL System Health Report (7/1/2012-9/30/2012) states that: Indicator of Industry Contact: "Establish industry contacts with ASME Code committee representatives, peers at other nuclear utilities, and outside consultants as necessary to ensure that inspection, examination and testing programs properly utilize external operating experience" The report indicates that there are no formal groups, other than the ASME code committee, and no active involvement

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	corrosion, and mechanical testing of the tendon bars also show no significant change in properties. While no specific inspection criteria were provided for the grout, it was noted that the grout cracked as the pipe was cut and stress relieved from the bars. In addition, in some areas, separated grout had a reddish-brown stain at the contact surface with the bars, which was suspected to be an oxide that formed during construction. - The following below-grade or submerged structures exposed to ground water or lake water were inspected to assess the effects of the aggressive ground/lake water. The inspection results are: 1) Below-grade of the RAB (Reactor Auxiliary Building): A visual inspection of the below-grade portion of the RAB foundation approximately three feet deep was performed in July 1999. No signs of spalling or other concrete degradation were observed. 2) Submerged portions of the intake structure: An inspection of the inaccessible areas was performed in 1999, using divers and video equipment. The concrete located at the water line showed signs of erosion from the constant wave action. The topcoat of mortar has eroded away, leaving the aggregate exposed. The average loss of cover is approximately 1/16 inch to 1/8 inch. 3) Submerged dam spillway: An underwater inspection was performed in 2000, by divers. A spalled portion of concrete (6' by 8" by 4" deep) was identified. This area was repaired prior to the period of extended operation. 4) The interiors of eight manholes were visually examined in August 2002. The interior concrete has been partially submerged from ground water, and provides a similar	within industry in past years, or no active sharing across sites. This indicator is being identified as "Yellow". Verify any resolution or improvement of this indicator. 7. The AMP base document (RNP-L/LR-0617) addresses several CRs. However, most of the CRs occurred at least 10 years ago. Verify the CRs in the last 5 years for any aging related issues. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): GALL may recommend visual inspection of interior surface of manhole for detecting concrete degradation. If so, provide OE background.

Program Element	Element of Licensee's AMP (LRA Section B.3.14)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	environment as below-grade concrete (exposure to acidic ground water). No cracking, loss of material, or change in material properties was observed in the concrete surface. - The overall health (between 7/1/2012- 9/30/2012) of the IWE/IWL Containment Inspection Program/Plan at RNP is White with a score of 87.50. The trend in the program health is rated stable.	

B.26.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.26.5. Documents Reviewed during the Audit

1. 10 CFR 50.55a.
2. EC 52368, Access and inspection of CV Liner at Regenerative Heat Exchanger and Refueling Canal.
3. EGR-NGGC-0015, Rev. 4, Containment Inspection Program
4. EGR-NGGC-0211, Rev. 0, ASME Section XI Repair/Replacement Program
5. IN 2010-14, Containment Concrete Surface Condition Examination Frequency and Acceptance.
6. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
7. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
8. MNT-NGGC-0024, Rev. 4, Excavation and Backfill.
9. NDEP-0620, Revision 7, VT-1 and VT-3 Visual Examination of ASME Section XI, Subsection IWE and IWL Components of Nuclear Power Plants
10. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
11. One-Time Inspection Summary Report (Doc. 66 in RNP License Renewal Portal)
12. Program Health Report, Rev. 3, IWE IWL Program (7/1/2012- 9/30/2012)

13. RG 1.90, Rev. 2, Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons.
14. RNP-L/LR-0617, Rev. 2, Aging Management Program, ASME Section XI, Subsection IWL, June 22, 2009
15. TMM-005, Rev. 28, 10 CFR 50, Appendix J Testing Program
16. TMM-104, System Walkdown Procedure.
17. TMM-124, Rev. 11, Inservice IWE/IWL Program

B.26.6. Summary

Robinson implements this program through its AMP B.3.14 ASME Section XI, Subsection IWL Program. The program manages the concrete portions of the containment building for change in material properties, loss of material, and cracking. The program consists of periodic visual inspection of concrete surfaces of the RNP containment for signs of degradation, assessment of damage, and corrective actions. The program is an existing RNP program with an enhancement that requires examination of representative samples of below-grade concrete be performed, when excavation is available for any reason.

This program is implemented through the following procedures:

- MNT-NGGC-0024 Excavation and Backfill Revision 4
- NDEP-0620 VT-1 and VT-3 Visual Examination of ASME Section XI, Subsection IWE and IWL Components of Nuclear Power Plants Revision 7
- EGR-NGGC-0015 Containment Inspection Program Revision 4
- TMM-124 Inservice IWE/IWL Program Revision 11
- EGR-NGGC-0211 ASME Section XI Repair/Replacement Program Revision 0
- TMM-005 10 CFR 50, Appendix J Testing Program Revision 28

The ground water and lake water at RNP are considered aggressive (low PH value) in the license renewal application. To address aging management of inaccessible areas in containment, such as basemat, exposed to aggressive ground water, the AMP includes the tasks: 1) To use inspections of submerged portions of concrete throughout the site as a leading indicator for potential containment concrete degradation, 2) to monitor groundwater and lake water for aggressiveness, and respond accordingly if a negative trend was identified, and 3) to inspect below-grade concrete, when exposed for any reason. As noted above, prior to the period of extended operation, enhancement will be made to administrative controls, to require supervisors to notify Civil/Structural Design Engineering of the location and extent of proposed excavations of foundation concrete, and to require Civil/Structural Design Engineering to examine representative sample areas of below grade concrete, when excavated for any reason.

The RNP containment is a prestressed containment with vertical grouted tendons in the cylindrical part of the containment. Only two nuclear power plants in the United State have used grouted tendon. The other one is Three Mile Island Unit 2, which is permanently shut down. The tendons are grouted in place and are considered bonded, since they are encased in grout, sealed within sleeves, and embedded in concrete. The tendons are permanently inaccessible. The ASME Section XI, Subsection IWL rules regarding unbonded post-tensioning systems are not applicable to the RNP containment. During the initial construction, two surveillance tendon blocks were constructed with the same outdoor environment as that of the service tendon. The surveillance block tendons were inspected and tested at 5- and 25-year intervals, with no significant corrosion, and no significant change in properties. During the audit session, RNP engineers stated that there are no surveillance bars remaining for inspection during the period of extended operation. To address the lack of monitoring and to provide assurance of the remaining capacity, RNP committed in the license renewal application (Commitment #45) that a Structural Integrity Test (SIT) of the tendon system will be performed during the period of extended operation. The test will be coupled with IWL visual inspections, with emphasis on identifying horizontal cracks, indicative of reductions in the prestress.

The First Ten-Year Inservice IWE/IWL Inspection Interval, examinations were performed in accordance with the ASME B&PV Code, Section XI, 1992 Edition with 1992 Addenda. The interval began on September 9, 1998 and ended on September 8, 2008. The Second Ten-Year Inservice Inspection Interval is being conducted in accordance with the ASME B&PV Code, Section XI, 2001, Edition with Addenda through 2003. The second Ten-Year Interval began on September 9, 2008 and ends on September 8, 2018. Since implementation, the IWL visual surface examinations have not identified any significant structural degradation. Minor concrete spalling and leaching has been identified and evaluated, with no structural impact identified. The number of findings does not indicate a negative trend.

Other topics noted in the audit session include:

- During refueling operations at RNP, the reactor cavity is flooded with borated water from the refueling water storage tank to enable submerged fuel movement. The structure has reinforced concrete walls with a stainless steel liner. In 2012, RNP performed an evaluation of potential concrete degradation by borated water leakage from reactor cavity seal. The analysis concluded that the reinforced concrete inside containment that may have been in contact with this leakage would not have experienced significant degradation.

- ASME Section XI, Subsection IWL rules regarding unbonded post-tensioning systems are not applicable for the prestressed containment structures with grouted tendons. For future revisions of the GALL Report, it is recommended including guidance for aging management of prestressed containment structures with grouted tendons, in accordance with Regulatory Guide 1.90 Rev. 2 (Nov. 2012), including the 5-year interval of conducting containment pressure testing.

- The Structural Integrity Test (Commitment #45) used to identify any degradation in the prestress system will only be done once in the PEO and will not be completed until 2017. This frequency of testing does not meet the current guidance in Regulatory Guide (RG) 1.90 Rev. 2, which recommends conducting pressure testing every five years. During the audit, RNP engineers stated that they would look into RG. 1.90 for the frequency interval of conducting containment pressure testing.

- Based on the plant operating experience, it appears that the RNP ASME Section XI, Subsection IWL program is effective in aging management of containment concrete. The corrective actions have been appropriate, and the number of findings appears to be appropriate, and does not indicate a negative trend.

Reference:

NRC Regulatory Guide 1.90, Revision 2, Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons, November 2012.

B.27 10 CFR Part 50, Appendix J Program (LRA Section B.2.7)

Associated GALL Report AMP: **2001 GALL Report, XI.S4 10 CFR Part 50, Appendix J Program**

B.27.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.2.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	This program consists of inspections of accessible surfaces of containment and monitoring of leakage rates through containment liner/welds, penetrations, fittings, and access openings, for detecting degradation of the containment pressure boundary. Corrective actions are taken if leakage rates exceed acceptance criteria. This program is implemented in accordance with 10 CFR Part 50, Appendix J, Regulatory Guide 1.163, and NEI 94-01, Rev. 0.	No significant issue or further review item was identified.
1. Scope of Program	The Robinson LRT program is described in the CP&L corporate procedure EGR-NGGC-0015 and Plant Program Procedure PLP-025, and implemented by Technical Management Procedure TMM-005. TMM-005 directs the performance of Type A, B, and C leak rate tests for the RNP containment, and all its penetrations, and meets the requirements of Option A of 10 CFR 50 Appendix J, Section III for type B and C tests, and Option B of 10 CFR 50 Appendix J, Section III for type A tests. An inspection of the accessible surfaces of the containment is performed during each refueling outage as directed in EST-064 and cited by TMM-124, to further satisfy the requirements of Option B of 10 CFR 50 Appendix J Section III for type A tests. EST-064 references additional procedures that perform various lower tier leak-testing functions.	1. Verify that Appendix J requires a general visual inspection of the accessible interior and exterior surfaces of the containment structure and components be performed, prior to any leakage rate Type A tests, in order to allow early detection of structural and component degradation as stated in GALL. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Consider adding aging effects/mechanisms in the GALL AMR table for penetration sleeves and penetration bellows. This includes loss of material due to galvanic corrosion and aggressive chemical attack

Program Element	Element of Licensee's AMP (LRA Section B.2.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
2. Preventive Actions	This is an inspection program and no actions are taken as part of this program to prevent or mitigate aging degradation.	No significant issue or further review item was identified.
3. Parameters Monitored/ Inspected	Parameters Monitored/ Inspected of the aging effects/mechanisms are: • Cracking due to Elevated Temperature • Cracking due to Thermal Fatigue • Change in Material Properties due to Elevated Temperature • Loss of Material due to General Corrosion • Loss of Material due to Wear • Loss of Material due to Aggressive Chemical Attack • Loss of Material due to Crevice Corrosion • Loss of Material due to Galvanic Corrosion • Loss of Material due to Pitting Corrosion TMM-005, in combination with other specific procedures, monitors the leakage rates through containment shells, containment liners, and associated welds, penetrations, fittings, and other access openings, by periodic performance of Type A, B, and C leak rate testing.	No significant issue or further review item was identified.
4. Detection of Aging Effects	The SER states that: Type B tests are conducted on a refueling outage interval, not to exceed a maximum interval of two years. This frequency will continue to be used for the period of extended operation. Leakage limits are not established for individual penetrations that have bellows. Limits are established for groups of mechanical penetrations. If any group of mechanical penetrations exceeds its limit, the individual penetration(s) is isolated for evaluation and repair. This allows detection of degradation of individual bellows on the penetrations during Type B testing. The RNP Appendix J program implemented by the various	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.2.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	procedures has proven to be effective in detecting degradation of containment shells, liners, and components that compromises the containment pressure boundary, including seals and gaskets, as reflected in the operating experience review.	
5. Monitoring and Trending	RNP-L/LR-0615 "Aging Management Program 10 CFR Part 50 Appendix J Program" states that: The Type B and C tests are performed at a refueling cycle frequency in accordance with the requirements of Option A of 10 CFR 50 Appendix J, and Type A tests are performed at a performance based frequency in accordance with the requirements of Option B of 10 CFR 50 Appendix J. TMM-005 references NEI 94-01 as the basis for Type A testing frequency, and also references Regulatory Guide 1.163. Technical Specification 5.5.16 further states that the Appendix J program is in accordance with the guidelines presented in Regulatory Guide 1.163.	1. One important factor of containment aging management is that the test results of Appendix J should be compared with previous results, to examine the performance history of the overall containment system, to limit leakage, and to track the degradation. Verify the performance history of the containment leakage.
6. Acceptance Criteria	Acceptance criteria for leakage rates are defined in plant technical specifications.	No significant issue or further review item was identified.
7. Corrective Actions	EGR-NGGC-0015 directs repair/replacement activities be performed for failures to meet the requirements of 10 CFR 50 Appendix J. Repair/replacement activities at RNP are performed in accordance with TMM-015. The specific procedures for individual leak tests (referenced in EST-064) each contain specific instructions, requiring repair or replacement, and retesting, for any isolation component that has excessive leakage. Such occurrences are processed according to the provisions of CAP NGGC-0200, Corrective Action Program, to ensure their proper disposition.	No significant issue or further review item was identified.
8. Confirmation	EGR-NGGC-0015 includes a requirement that the 10 CFR 50 Appendix J acceptance criteria be satisfied, before	N/A – this is boilerplate and items of concern are not expected for this element.

Program Element	Element of Licensee's AMP (LRA Section B.2.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Process	returning the affected component to service after repair. This is further ensured by the specific procedures for individual leak tests (referenced in EST-064), which each contain specific instructions requiring repair or replacement, and retesting, for any isolation component that has excessive leakage. TMM-005 further requires an increase in Type A testing frequency following failure of any Type A test. Program effectiveness is monitored using site quality assurance (QA) procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Procedures utilized include: ADM-NGGC-0104, Work Management Process ADM-NGGC-0203, Preventive Maintenance and Surveillance Testing Administration MMM-001, Maintenance Administration Program CAP-NGGC-0200, Corrective Action Program CAP-NGGC-0201, Self-Assessment Program AP-022, Procedure Review and Approval Process These elements are consistent with the activities described in Section XVI of 10 CFR 50 Appendix B.	
9. Administrative Controls	EST-064 directs the confirmation of the acceptability of the Type B and C test results, and appropriate documentation of failures or discrepancies. Such documentation results in repair/replacement of affected components and assessment of the condition under 10 CFR 50.72 and 10 CFR 50.73. Similar administrative controls direct performance of similar activities following performance of Type A tests (see EST-085, Containment Integrated Leak Rate Test, [ILRT], currently on "hold" due to its infrequent	1. Verify meaning of the statement: Containment Integrated Leak Rate Test, currently on "hold" due to its infrequent performance interval.

Program Element	Element of Licensee's AMP (LRA Section B.2.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	performance interval).	
10. Operating Experience	The SER states: A review of plant OE determined many of the original bellows have been replaced due to excessive leakage from damaged bellows. The OE provides assurance the 10 CFR 50 Appendix J Program has been successful at detection of leakage at penetration bellows and implementing actions to replace bellows as necessary.	1. LRA Table 3.5-1 line item 2 states that: The sole occurrence of SCC on penetration bellows at RNP involved a stainless steel bellows exposed to chlorides This was corrected by changes to the penetration design and by replacing the piping insulation with a chloride-free type. The SER also states: A Steam Generator Blowdown bellows failed due to a crack caused by TGSCC. Condensation of water from the penetration pressurization system supplied air inside the penetration, wetted the pipe insulation, and transported the chlorides contained in the insulation materials to the penetration bellows. The presence of the chlorides on the SS material of the bellows caused the bellows to fail. The insulation was replaced with chloride free insulation. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): It is recommended to add this OE to GALL (i.e, chlorides contained in the piping insulation materials causing failure of penetration bellows). 2. The pressure of Appendix J tests in some plants has been increased after EPU modification. Verify this case, if RNP has an EPU modification. 3. Verify the CRs from Appendix J leak rate tests in last 5 yrs. 4. The AMP base document states that: Several incidents involving discrepancies found during leak rate testing that resulted in CRs and LERs being submitted are tabulated in RNP-LR/L-0372, Aging Management Review - Containment Structure, Internal and External Structural Components (Reference 5.22). These items further validate the effectiveness of the 10 CFR 50

Program Element	Element of Licensee's AMP (LRA Section B.2.7)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		Appendix J program for timely detection of containment integrity degradation. a) RNP-LR/L-0372 is not in the RNP portal. b) Verify what are these CRs and LERs.

B.27.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.27.5. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. 10 CFR 50, Appendix J.
3. 10 CFR 50.72
4. 10 CFR 50.73
5. ADM-NGGC-0104, Work Management Process
6. ADM-NGGC-0203, Rev. 18, Preventive Maintenance and Surveillance Testing Administration.
7. ANSI B30.2
8. CAP-NGGC-0200, Rev. 34, NGG Standard Procedure.
9. CAP-NGGC-0201, Self-Assessment Program.
10. Draft Regulatory Guide DG 1.197, April 2011
11. EGR-NGGC-0015, Rev. 4, Containment Inspection Program
12. EST-064
13. EST-085, Containment Integrated Leak Rate Test
14. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
15. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
16. MMM-001, Maintenance Administration Program

17. NEI 94-01, Rev. 0.
18. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
19. PLP-025, Rev. 15, Inservice Inspection Programs, June 2004.
20. RG 1.163
21. RNP-L/LR-0372, Aging Management Review, Containment Structure, Internal and External Structural Components (Reference 5.22).
22. RNP-L/LR-0615, Rev. 1, Aging Management Program, 10 CFR Part 50 Appendix J Program
23. RNP Technical Specifications
24. TMM-005, Rev. 28, 10 CFR 50, Appendix J Testing Program
25. TMM-015
26. TMM-124, Rev. 11, Inservice IWE/IWL Program

B.27.6. Summary

The RNP containment has vertical grouted tendons in the cylindrical part of the containment. Only two nuclear power plants in the U.S. have used grouted tendon. The other one is Three Mile Island Unit 2, which is permanently shut down.

During the audit, RNP explained that the RNP Type A ILRT is option B (performance based), type B and C are option A. The last ILRT was performed in 2007. No issue was found in the 2007 ILRT. RNP entered the period of extended operation (PEO) in 2010. In the PEO, RNP will perform the ILRT once. The next ILRT is scheduled in 2017.

The staff mentioned in the audit that the Draft Regulatory Guide DG-1197 April 2011 (proposed Revision 2 of Regulatory Guide 1.90, Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons) recommends ILRT for grouted containment be performed once every 5 years.

Regarding the limit specified for each penetration, RNP explained there is a limit of the combined leakage. Once the combined limit is exceeded, it will identify the penetrations with leakage and will fix them. There is no limit specified for each penetration.

The RNP has undergone EPU (extended power uprate). The pressure is increased slightly after EPU, based on containment analysis. This is consistent with other plant in increasing ILRT test pressure after EPU.

Many of the original penetration bellows have been damaged by SCC, due to exposure to chlorides in the piping insulation. This was corrected by changes to the penetration design and by replacing the piping insulation with a chloride-free insulation. RNP engineers indicated that the problem does not exist anymore.

In general, the RNP 10 CFR Part 50, Appendix J Program appears effective. The responsible engineers are knowledgeable of the AMP.

B.28 Structures Monitoring Program (LRA Section B.3.15)

Associated GALL Report AMP: **2001 GALL Report, XI.S6 Structures Monitoring**

B.28.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The Structures Monitoring Program is a combination of CP&L corporate procedure EGR-NGGC-0351 (Condition Monitoring of Structures) and Plant Technical Management Procedure TMM-104 (System Walkdown Procedure.) EGR-NGGC-0351 provides direction to the Responsible Engineer for monitoring the structural condition of systems included in the scope of 10 CFR 50.65, known as the "Maintenance Rule". TMM-104 provides instructions for conducting scheduled system walkdowns, generating system heath reports, and performance monitoring of structures. The program consists of periodic inspection and monitoring the condition of structures and non-ASME structure component supports. The inspection criteria are based on ACI 349.3R-96 and ASCE 11-90; as well as INPO Good Practice document 85-033, "Use of System Engineers," NEI 96-03, "Guidelines for Monitoring the Condition of Structures at Nuclear Plants," and NUMARC 93-01, "Industry Guidelines for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants." The program will be enhanced to: • Include buildings and structures, and associated acceptance criteria, in scope for license renewal, but outside the scope of the Maintenance Rule. (Structures addressed in the Maintenance Rule already are in the Program.)	1. Safety or non-safety components could fall on adjacent safety components (i.e., II on I effects) during seismic events. Therefore, the following item may be included in the GALL update. "Expand system walkdown inspection criteria to include observation of selected, adjacent components." 2. The SER states that the applicant will include the follow item in the AMP as an enhancement. Degradation to submerged concrete observed during periodic under water inspections at the intake structure and RNP dam spillway will be used as a "leading indicator" for potential degradation to below-grade concrete structures, in the scope of license renewal. Below-grade concrete will be evaluated and/or examined for potential degradation, and corrective actions taken as determined by Engineering. This applies to below-grade concrete examined by the Structures Monitoring Program and the ASME Section XI, Subsection IWL Program. Applicable sections of the procedures for these two AMPs will be enhanced to incorporate these changes. Verify whether this enhancement is also reflected in the ASME Section XI, Subsection IWL ISI program procedures. 3. The SER states, "Response to the staff's concerns, the applicant proposed to use its periodic inspections of the submerged portions of the intake structure and dam

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	• Identify interfaces between structures monitoring inspections of concrete surfaces and the Fire Protection Program requirements for barriers. • State clearly the boundary definition between systems and structures. The physical structure is inspected as part of the structure/building walkdown, and includes the concrete structure and all structural steel such as: Main building structural steel, platform support steel, stairways, etc. • Revise administrative controls to provide inspection criteria for portions of systems covered by structures monitoring. Provide acceptance categories similar to those used for Structures Monitoring, and require a condition report be initiated for all inspection attributes found to be unacceptable. • Expand system walkdown inspection criteria to include observation of selected adjacent components. • Revise personnel responsibilities to include responsibilities to (1) provide assistance in evaluating structural deficiencies, when requested by the Responsible Engineer, (2) inspect excavated concrete, and (3) notify Civil/Structural Design Engineering of location and extent of proposed excavations. The above enhancements are part of Commitment #26 and were to be implemented through the administrative controls for the Structures Monitoring Program, prior to the period of extended operation.	spillway as indicators for the condition of below-grade concrete at RNP. Because the ground water and lake chemistry are similar, degradation to submerged concrete will be used as a leading indicator for the potential degradation to below-grade concrete structures. This commitment was designated as Confirmatory Item 3.5-1." Ask for the inspection frequency of the intake structure and dam spillway in the periodic inspection proposed by the applicant. 4. IR 2010008 (April 7, 2010) states that at the time of this inspection, the Commitment #26 was partially completed and additional tasks were pending to be implemented prior to the period of extended operation. Verify the status of implementation of Commitment #26.
1. Scope of Program	The Structures Monitoring Program is credited for aging management of civil structures and components within the scope of license renewal at RNP. SER states "The Structures Monitoring Program manages aging of the seismic joint filler commodity by visual inspection to note any indication of movement or distress,	1. Robinson LRA Table 3.5-1 line item 25 states "Carbon steel parts of slide bearing plates used for non-ASME components are included in this aging management program." GALL may consider including carbon steel parts of slide bearing plates used for non-ASME components as a line

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	as well as a determination that the gaps meet design requirements and are free of debris. The Structures Monitoring Program] manages aging of roof material by a visual inspection for degradation, damage, and/or leakage." Seismic Gap Evaluation: Consider the seismic gap expansion filler to determine the condition of the joint, and to note any indication of movement or distress. Check for unexpected moisture or debris. Measure gap for comparison to design requirements.	item and managed by the Structures Monitoring AMP. GALL has sliding plate made of Lubrite, Fluorogold, and Lubrofluor, managed by Structures Monitoring Program (item III.A4.TP-35, III.B2.TP-46). However, GALL does not have a line item for carbon steel parts of sliding plates. 2. Seismic joint filler (indoor) and roof membrane (outdoor) made of elastomer materials are managed by the RNP Structure Monitoring Program, for change in material properties from elevated temperature and cracking from elevated temperature. These components and materials are not addressed in the GALL Report, and may be consider for inclusion as line items in GALL updates. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): It is recommended that adding inspection and monitoring of seismic joint filler and gaps between structures in the GALL. **Technical Basis**: Degradation of seismic joint filler and reduction of gap size increase the potential of structural impact during a seismic event.
2. Preventive Actions	No preventive actions are specified, the program is a condition-monitoring program.	1. GALL Rev. 2 recommends preventive actions for proper selection of bolting material, lubricants, and installation torque or tension, to prevent or minimize loss of bolting preload and cracking of high strength bolting.
3. Parameters Monitored/ Inspected	Parameters Monitored/Inspected includes: Steel aging effects/mechanisms: • Loss of Material due to General Corrosion • Loss of Material due to Crevice Corrosion • Loss of Material due to Pitting Corrosion Concrete (below-grade) aging effects/mechanisms: • Loss of Material due to Aggressive Chemical Attack • Loss of Material due to Corrosion of Embedded Steel • Change in Material Properties due to Aggressive	No significant issue or further review item was identified. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): Add seismic joint filler such as Change in Material Properties and Cracking due to Elevated Temperature. **Technical Basis**: Degradation of seismic joint filler and reduction of gap size increase the potential of structural impact during a seismic event.

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Chemical Attack Elastomer aging effects/mechanisms: • Change in Material Properties due to Elevated Temperature • Cracking due to Elevated Temperature	
4. Detection of Aging Effects	Table 3.5-1 line item 17 states, "The aging mechanisms associated with aggressive chemical attack and corrosion of embedded steel, are applicable only to below-grade concrete/grout structures owing to the slightly acidic pH of groundwater. The Structures Monitoring Program is applicable to these structures. RNP will apply a special, plant-specific inspection provision to monitor aging effects caused by aggressive chemical attack and corrosion of embedded steel for below grade concrete in this component/commodity group. This will include inspection of below grade concrete and grout exposed during excavation." The Structures Monitoring Program requires the accessible portions of all maintenance rule systems and specific non-maintenance rule systems be fully walked down within one operating cycle. The inspection interval for Maintenance Rule structures, such as the Reactor Auxiliary Building, Fuel Handling Building, etc., are walked down with a frequency not to exceed ten years, in accordance with the maintenance rule guidelines.	1. The ground water of the NWP site is aggressive (i.e., average pH of 4.4). Verify the results of inspection of below grade concrete and grout during the extended period of operation. Verify the interval of ground water monitoring. GALL Rev. 2 states that in general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. Ten-year intervals for walkdowns for Reactor Auxiliary Building, Fuel Handling Building, etc., are too long. Verify the walkdown frequency for Maintenance Rule structures, such as the Reactor Auxiliary Building, Fuel Handling Building, etc. It appears there is a major discrepancy between the RNP's Structures Monitoring Program and GALL. GALL suggests monitoring of all structures not to exceed 10 years. It appears that RNP divides structures into two categories, some structures are under Maintenance Rules, and some structures are under Structures Monitoring program. For structures under Maintenance Rules, the walkdown interval for monitoring could be as long as ten years. GALL recommends all structures are managed by Structures Monitoring Program and recommends monitoring interval not to exceed 5 years. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): (1) "Degradation of submerged concrete observed in underwater inspections" as a leading indicator in GALL for potential degradation to other below-grade concrete structures in the scope of License Renewal.

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		Technical Basis: Degradation of submerged concrete observed in underwater inspections by divers would indicate potential degradation for all below-grade concrete structures in the scope of License Renewal. (2) "Increasing aggressiveness of the ground water/lake water" as a leading indicator in GALL for potential degradation to below-grade concrete structures. ***Technical Basis:*** Increasing aggressiveness of the groundwater/lake water would indicate potential degradation for all below-grade concrete structures in the scope of License Renewal
5. Monitoring and Trending	System Health Reports are generated for all systems within the scope of TMM-104, no less than once a year and twice a year for selected systems. Reports are documented in a format similar to that shown in Attachment 10.6 and are retained in the system notebooks for three years. EGR-NGGC-0010, "System & Component Trending Program and System Notebooks" provides specific information on system notebooks. Such monitoring and trending is a satisfactory basis for meeting the attribute. Plant Procedure TMM-104 is enhanced to include trending requirements for structures based on aggressive ground water and lake water. The requirements include: - Degradation to submerged concrete observed during periodic underwater inspections at the Intake Structure and RNP Dam Spillway will be used as a leading indicator for potential degradation to below grade concrete structures in the scope of License Renewal. - Degradation to below grade concrete exposed during excavation will be used as a leading indicator for potential degradation to remaining below grade concrete structures in the scope of License Renewal.	The SER states that the water monitoring results (pH, chlorides, sulfates) will be reviewed by Engineering and trended. Increasing aggressiveness of the ground water and lake water will also be used as a "leading indicator" for potential degradation to below-grade concrete structures in the scope of license renewal as described above. 1. Verify the trending of ground water. 2. GALL may consider increasing aggressiveness of the ground water as a leading indicator for potential degradation to below-grade concrete structures in the scope of license renewal.

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	- Groundwater and lake water monitoring results (pH, chlorides, sulfates) will be reviewed by Engineering and trended. Increasing aggressiveness of the groundwater and lake water will be used as a leading indicator for potential degradation to below grade concrete structures in the scope of License Renewal. - Engineering will evaluate if the leading indicators for potential degradation to concrete are common to other structures in the scope of License Renewal (including ASME Section XI, Subsection IWL), and will initiate appropriate corrective actions.	
6. Acceptance Criteria	A set of inspection attributes and acceptance standards are provided for steel, concrete, and elastomers. Structures are determined to be "ACC" (Acceptable), "AWD" (Acceptable with Deviations), and "UNA" (Unacceptable). Acceptance criteria are commensurate with industry codes, standards, and guidelines; such as NUMARC 93-01, ACI 349.3R-96, ASCE 11-90; and industry and plant-specific operating experience is considered. The concrete surfaces inspection quantitative acceptance criteria described in ACI 349.3R-96 are implemented. Concrete surface condition attributes are generally acceptable without further evaluation if: - Pop-outs or voids are less than 20mm (3/4-in.) in diameter or equivalent surface area - Scaling is less than 5mm (3/16-in.) in depth - Spalling is less than 10mm (3/8-in.) in depth and 100mm (4¼-in.) in any dimension - Passive cracks are less than 0.4mm (0.015-in.) in maximum width Concrete Surfaces and Water Infiltration Inspection	Verify conditions of ground water leakage (ground water seepage) or other seepage in the below-grade and embedded concrete structures Verify if RNP has any active leakage detection system. If yes, what are the measured and acceptable leakage rates?

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Process: Concrete surfaces that have been protectively lined with either a metallic or plastic (non-polyvinyl chloride) liner system are acceptable under the following criteria: a) Without active leak detection system: - Absence of bulges or depressions in liner plate, which are age related - Absence of corrosion or other liner damage - Absence of cracking or deterioration of base metal and weld metal - Absence of detectable leakage in leak detection system, which is in excess of amounts, and flow rates in the original design or technical specifications. b) With active leak detection system: - Leakage exceeding amounts and flow rates in the original design or Technical Specifications. Leakage within the prescribed limits may be acceptable if the source is known and not found to be consequential.	
7. Corrective Actions	Condition Report is initiated for any condition identified as "Unacceptable". Condition Reports are controlled as part of the Corrective Action Program (CAP-NGGC-0200), which is in accordance with 10 CFR Part 50, Appendix B. Plant procedure TMM-104 is enhanced to require corrective action, as appropriate, in accordance with the Corrective Action Program for degradations or deficiencies that could compromise component or system design functions, or could prevent the ability to perform within design basis allowable load, stress, deflection, or functional limits.	No significant issue or further review item was identified.
8. Confirmation	Program effectiveness is monitored using site quality assurance	N/A – this is boilerplate and items of concern are not expected for this element.

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Process	(QA) procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. Procedures Utilized include: • ADM-NGGC-0104, Work Management Process • ADM-NGGC-0203, Preventive Maintenance and Surveillance Testing Administration • MMM-001, Maintenance Administration Program • CAP-NGGC-0200, Corrective Action Program • CAP-NGGC-0201, Self-Assessment Program	
9. Administrative Controls	Corporate and Site Quality Assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	A review of condition reports and inspections performed has concluded that administrative controls are in effect and are effective in identifying age related degradation, implementing appropriate corrective actions, and continually upgrading the administrative controls used for structural monitoring.	1. SER states that inspection of the submerged portion of Intake Structure (i.e., inaccessible areas) was performed in 1999, using divers and video equipment. The concrete surface had very little marine growth. There was little or no sediment on the bottom slab. The concrete located at the water line showed signs of erosion from the constant wave action. The topcoat of mortar has eroded away leaving the aggregate exposed. The average loss of cover was approximately 1/16 inch to 1/8 inch. The concrete surface was cleaned of marine growth in a number of locations with a wire brush. The topcoat came off with minor effort, thereby exposing the aggregate. Sound material was observed at all cleaned locations. Several repairs were observed to have been made in various locations. One repair had flaked off and rebar was observed (one end cut). The repair material thickness was approximately 2 inches and the repair area was about 1 square foot. This area was

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		determined by the RNP Engineering Section to have no impact on the structural integrity of the concrete. Ask if any additional inspection has been performed since 1999. If not when is the next inspection scheduled? Verify whether the resolution of the video equipment is adequate to detect cracks of concrete. 2. SER states that an underwater inspection of dam spillway was performed on June 20, 2000, by divers. The spillway inspection examined the condition of concrete, especially at the tainter gates. A spalled portion of concrete (6' by 8" by 4" deep) was identified. This area is scheduled to be reinspected and repaired prior to the period of extended operation. The Dam Inspection Program will monitor the condition of the normally inaccessible submerged spillway concrete surfaces, at a frequency not to exceed 10 years. No other underwater concrete degradation was identified. As a result of degradation found in inspection of intake structures and the dam spill ways, the applicant agreed the following: Degradation to submerged concrete observed during periodic under water inspections at the intake structure and RNP dam spillway will be used as a leading indicator for potential degradation to below-grade concrete structures in the scope of license renewal. Below-grade concrete will be evaluated and/or examined for potential degradation, and corrective actions taken, as determined by Engineering. This applies to below-grade concrete examined by the Structures Monitoring Program and the ASME Section XI, Subsection IWL Program. Applicable sections of the procedures for the Structures Monitoring and ASME Section XI, Subsection IWL programs will be enhanced to incorporate these changes.

Program Element	Element of Licensee's AMP (LRA Section B.3.15)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
		Check how leading indicators are defined in the RNP procedures. The interval of 10 years on monitoring of the normally inaccessible, submerged spillway concrete surfaces appears too long. GALL Rev. 2 states that in general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. 3. SER states that the applicant proposed to use the periodic inspection results of the "submerged portions" of the intake structure and dam spillway as indicators for the condition of "below-grade concrete" at RNP. Because the ground water and lake chemistry are similar, degradation to submerged concrete will be used as a leading indicator for the potential degradation to below-grade concrete structures. The applicant committed to modify the Structures Monitoring Program to add this enhancement. For plants with similar ground water and lake chemistry, GALL may consider using degradation experienced in the submerged structures (exposed to lake environment) as "leading indicators" for potential degradation to below-grade concrete structures exposed to ground water. **ACTION ITEM for Consideration for writing SLR-GDs** (as result of audit): Provide some OE regarding roof leaking, because roof leaking could cause problems for electric equipment below the roof, and repair is expensive.

B.28.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.28.5. Documents Reviewed during the Audit

1. 10 CFR 50.65, Maintenance Rule.
2. ACI 349.3 R-96
3. ADM-NGGC-0104, Work Management Process
4. ADM-NGGC-0203, Rev. 18, Preventive Maintenance and Surveillance Testing Administration.
5. ANSI B30.2
6. ASCE 11-90
7. ASME Section XI, Subsection IWL Program
8. CAP-NGGC-0200, Rev. 34, NGG Standard Procedure.
9. CAP-NGGC-0201, Self-Assessment Program.
10. EGR-NGGC-0010, “System & Component Trending Program and System Notebooks
11. EGR-NGGC-0351, Rev. 18, Conditions Monitoring of Structures.
12. INPO 85-033, Use of System Engineers.
13. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
14. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
15. MMM-001, Maintenance Administration Program
16. NEI 96-03, Guidelines for Monitoring the Condition of Structures at Nuclear Plants.
17. NUMARC 93-01, “Industry Guidelines for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants
18. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
19. RNP-L/LR-0608, Rev. 3, Aging Management Program, Structures Monitoring Program.
20. TMM-104, System Walkdown Procedure.

B.28.6. Summary

RNP explained the major differences between Maintenance rules and Structures Monitoring AMP. The Structures Monitoring AMP focuses on finding aging related issues.

Some buildings at RNP with flat roofs have experienced roof leaking. Roof leaking could cause electric problems. During the audit, RNP was requested to provide the recent CRs on roof leaking. RNP indicated that roof replacement is very expensive.

If good care is taken, a roof can be used more than 10 years. The audit team felt that GALL may need to provide some guidance on roof leaking.

On the fire wall inspection, RNP indicated that the fire walls are also inspected by fire protection team. The fire protection team conducts fire wall inspection more frequently than structures monitoring.

The audit team indicated that most CRs in the portal are more than 10-years old. The team requested to see recent CRs.

The RNP ground water is aggressive (low pH value). RNP was requested to provide several years of ground water monitoring results. In ground leaking, RNP indicated that ground leakage is not a problem.

RNP asked what the neutron effect on concrete degradation is. NRC staff replied that no changes is needed in NRC regulatory requirements in this respect based on Japanese data.

On inspection of support, RNP indicated that supports are sampled for inspection. There are thousands of supports in a plant. Inspection of every support is not necessary, impractical, and wastes man power.

Structures under Maintenance Rules such as the Reactor Auxiliary Building, Fuel Handling Building, etc., are walked down with a frequency not to exceed ten years, in accordance with the maintenance rule guidelines. Interval will be changed based on tracking and trending. The staff noted that Crystal River 3 (CR-3) has changed the inspection interval of structures from 10 years. It appears there is a major discrepancy between the RNP's Structures Monitoring Program and GALL. GALL suggests monitoring of all structures not to exceed 5 years. It appears that RNP divides structures into two categories; some structures are under Maintenance Rules such as Reactor Auxiliary Building, Fuel Handling Building. For structures under Maintenance Rules, the walkdown interval for monitoring could be as long as ten years. Other structures are under Structures Monitoring program such as yard structures. These structures originally were not included in the Maintenance Rule, but they are in the scope of license renewal, managed by Structures Monitoring AMP, monitored in a much shorter interval such as in outage (GALL recommends all structures managed by Structures Monitoring Program with a monitoring interval not to exceed 5 years). One would think failure of Reactor Auxiliary Building and Fuel Handling Building have more safety impact than yard structures; however, they have a much longer inspection interval.

On the spent fuel pool leakage, RNP indicated that minor leakage at transfer canal of spent fuel pool.

RNP will provide follow-up information on following items:

1. Recent roof CRs

2. Recent CRs of structures

3. Ground water monitoring results in last 2 years

Two more questions forwarded to RNP after the session. :

1. What are the recent results of below grade concrete structures from excavations?

2. EGR-NGGC-0351 “Condition Monitoring of Structures” talks about inspection of the foundation drainage system. How often it is inspected? Is every building/structure in the scope of Maintenance Rule and Structure Monitoring AMP inspected for its drainage system? Is the inspection under Maintenance Rule or Structures Monitoring AMP? (GALL doesn’t contain inspection of foundation drainage system. It may be necessary to add this item to GALL.)

Questions related to water-controlled structures will be discussed in the Dam Inspection session on Thursday. One question was that the submerged spillway was inspected by diver in 1999 and degradation was found. Has the scope of the inspection expanded since 1999?

B.29 Dam Inspection Program (LRA Section B.3.16)

Associated GALL Report AMP: **2001 GALL Report, XI.S7 RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants**

B.29.3. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The Dam Inspection Program is covered under the XI.S6 AMP in the GALL Report. The RNP program manages the following aging effects: (1) Loss of material for steel structures, (2) loss of form for earthen structures, and (3) loss of material and change in material properties for concrete structures for the Lake Robinson Dam and associated concrete and steel structures. Detection of aging effects is accomplished by an independent inspection using the FERC/U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams." Prior to the period of extended operation, the following enhancements to the inspection program will be implemented. The system monitoring administrative controls will be revised to: 1) Identify the "Recommended Guidelines for Safety Inspection of Dams" as the required management program document for the dam, 2) Require the responsible system engineer to review the inspection report, and initiate corrective actions for any unacceptable attributes identified during the inspection process, and 3) Include "Recommended Guidelines for Safety Inspections of Dams" as the applicable inspection	1. IR 2010008 (April 7, 2010) states that the Dam Inspection Program Commitment #27 specified that prior to the period of extended operation, the administrative controls for the Dam Inspection Program system monitoring will be enhanced to: (i) Identify the "Recommended Guidelines for Safety Inspection of Dams" as the required document for the dam AMP, (ii) Require the responsible system engineer to review the inspection report, and initiate corrective actions for any unacceptable attributes, (iii) Include "Recommended Guidelines for Safety Inspections of Dams" as the applicable inspection guidance in the inspection procedure for the RNP dam inspection program, (iv) Inspect above-grade accessible concrete, (v) Inspect submerged spillway concrete on a frequency not to exceed ten years, and (vi) Include trending requirements for structures based on aggressive ground and lake water. The existing Dam Inspection Program manages aging effects for the Lake Robinson Dam and its associated concrete and steel structures. This program is currently implemented by an independent inspection using the

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	guidance in the dam inspection procedure for RNP.	Federal Energy Regulatory Commission (FERC)/U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams." a) GALL AMP XI.S7 specifies inspection of the water-controlled structures at least once every 5 years. Inspection of the spillway concrete not to exceed ten years may not be adequate. b) Examine the trending requirements as mentioned in item (6) above **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): (1) Use degradation of concrete in the submerged structures as a leading indicator for potential degradation to other below-grade concrete structures in the scope of license renewal, such as below-grade containment concrete. ***Technical Basis*:** Submerged structures can be periodically inspected by underwater divers without excavation. Degradation of concrete in the submerged structures would indicate potential degradation to other below-grade concrete in the scope of RNP license renewal, such as below-grade containment concrete. (2) Include periodic self-assessment of LR commitments and aging management activities in GALL. ***Technical Basis*:** The AMP self-assessment would ensure the LR commitment and aging management activities have been accurately implemented.
1. Scope of Program	The Dam Inspection Program is credited for management of aging effects/mechanisms of the steel, concrete, and earthen structures for the Lake Robinson Dam. The FERC/US Army Corp of Engineers program, "Recommended Guidelines for Safety Inspection of Dams," is credited by for this program. This program is	1. Check whether the Dam Inspection Program includes ground water monitoring at the dam site. Spillway could crack, due to various reasons, such as settlements, causing rebar to be exposed to ground water. It may be prudent to monitor ground water at the dam site to ensure that groundwater at the dam site is not aggressive. Note that

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	one of the acceptable alternatives for managing aging effects for water control structures in the GALL Report. The program includes inspection of concrete structures, embankments, spillways, and outlet works (gates, channels, sluices, etc.). Concrete Structures • Concrete Surfaces • Structural Cracking • Movement – Horizontal and Vertical Alignment • Junctions • Drains – Foundation, Joint, Face • Water Passages • Seepage or Leakage • Monolith Joints – Construction Joints • Foundation • Abutments Embankment Structures • Settlement • Slope Stability • Seepage • Drainage System • Slope Protection Spillway Structures • Control Gates and Operating Machinery • Unlined Saddle Spillways • Approach and Outlet Channels Outlet Works • Intake Structure • Operating and Emergency Control Gates • Conduits, Sluices, Water Passages, Etc. • Approach and Outlet Channels	the ground water at RNP site is aggressive (low pH value).

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
2. Preventive Actions	This is an inspection program and no actions are taken as part of this program to prevent or mitigate aging degradation.	The GALL XI.S7 is augmented to incorporate preventive measures recommended in NUREG-1339, Electric Power Research Institute (EPRI) TR-104213, EPRI NP-5067, and EPRI NP-5769 to ensure structural bolting integrity, if applicable. The documents provide guidelines for selection of replacement bolting material, approved thread lubricants, and appropriate torque and preload to be used for installation of bolting. If the structural bolting consists of ASTM A325, ASTM F1852, and/or ASTM A490 bolts, the preventive actions for storage, lubricants, and SCC potential discussed in Section 2 of RCSC (Research Council for Structural Connections) publication "Specification for Structural Joints Using ASTM A325 or A490 Bolts" should be used. The applicant may need to include preventive measures for anchor bolting to be consistent with GALL XI.S7.
3. Parameters Monitored/ Inspected	Parameters monitored/inspected include: Steel Structures Aging Effects/Mechanisms: • Loss of Material due to Crevice Corrosion • Loss of Material due to General Corrosion • Loss of Material due to Pitting Corrosion • Loss of Material due to MIC Earthen Structures Aging Effects/Mechanisms: • Loss of Form due to Settlement Concrete Structures Aging Effects/Mechanisms: • Loss of Material due to Aggressive Chemical Attack • Loss of Material due to Corrosion of Embedded Steel • Change in Material Properties due to Aggressive Chemical Attack	The parameters monitored/Inspection should include but not limited to the following: For concrete structures: Seepage, leakage, For earthen structures: Settlement, depressions, sink holes, slope stability (e.g., irregularities in alignment and variances from originally constructed slopes), seepage, proper functioning of drainage systems, and degradation of slope protection features.
4. Detection of Aging Effects	The method of identifying aging effects is based on an independent inspection using the "Recommended Guidelines for Safety Inspection of Dams."	1. NRC RG 1.127 and GALL XI.S7 describe special inspections immediately following the occurrence of significant natural phenomena, such as large floods,

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	The purpose of this dam safety inspection and report is to identify, within the limitations of visual field inspection and office review of available data, records and operating history, any actual or potential deficiencies, whether in the condition of the project works, the quality and adequacy of project maintenance, surveillance, or in the methods of operation, that might endanger public safety. The independent dam inspections are conducted at five-year intervals. The inspections are performed in accordance with the recommended guidelines for a Phase I dam safety inspection per the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams". A first time inspection of the submerged concrete on the spillway was performed in June 2000. This underwater inspection of concrete will be inspected at the frequency required for maintenance rule structures or not to exceed a frequency of (10) ten years. The technical investigations should be conducted under the direction of licensed professional engineers, experienced in the investigation, design, construction and operation of dams, applying the disciplines of hydrologic, hydraulic, soils and structural engineering, and engineering geology. All field inspections should be conducted by qualified engineers, engineering geologists, and other specialists, including experts on mechanical and electrical operation of gates and controls, knowledgeable in the investigation, design, construction, and operation of dams. H.B. Robinson uses independent consultants, qualified and experienced in the inspection of dams, per the subject management program. Required Program Enhancements: • Revise the System Walkdown Procedure (Reference 5.14, TMM-104) to identify the "Recommended Guidelines	earthquakes, hurricanes, tornadoes, and intense local rainfalls. It is not clear whether the RNP AMP includes such special inspections. 2. The RNP Quick Hit Self-Assessment performed on November 26-28, 2012 states that: <u>Dam Inspection Program</u> The program was reviewed and determined to meet or exceed the commitment requirements. However, there were questions about knowledge transfer for incoming staff. Additionally, it is recommended that the commitment binder be updated with more recent system walkdowns and trending of ground water sampling results. Verify the results of the recent system walkdowns, trending of ground water sampling results, and frequency of ground water sampling. 3. General Observation: The RNP quick hit self-assessment was performed as required by EGR-NGGC-0514, License Renewal Implementation Procedure, which requires the following: Perform periodic assessments of LR commitments and aging management activities at least once every three years. These assessments shall meet the following requirements: Review credited preventive maintenance activities to ensure they are being performed, and meet the requirements of LR commitments and aging management programs. Review credited procedures to verify they accurately reflect commitments and aging management programs. Review EGR-NGGC-0512 and Program Implementation Plans in PassPort to verify they accurately reflect the status of LR commitment and aging management program

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	for Safety Inspection of Dams" as the required management program for the H.B. Robinson Dam and require the responsible system engineer to review the report, and initiate corrective actions, for any unacceptable attributes identified during the inspection process. • Revise EGR-NGGC-0351 Attachment 1 "Dams, Embankments, and Canals" to include "Recommended Guidelines for Safety Inspections of Dams" as the inspection guidance for H.B. Robinson. • Revise TMM-104 to include an inspection of submerged spillway concrete at an interval not to exceed (10) ten years. • Revise TMM-104 to add a trending section to require degradation to submerged concrete observed during periodic under water inspections at the Dam Spillway to be used as a leading indicator for potential degradation to other below grade concrete structures in the scope of LR. The plant procedure NGR-NGGC-0351 requires: - Water-retaining structures should not have areas of differential settlement or construction joint gaps that allow water to leak beneath the structure, thereby causing soil erosion and concrete deterioration. Concrete cracking around spillway gates of dams may be due to high hydrostatic forces, differential settlement, and lack of maintenance. - The Lake Robinson Dam Embankment, accessible spillway concrete, and steel commodities shall be inspected at a 5-year inspection interval. This includes a full travel test of each tainter gate with the stop logs installed. The Lake Robinson Dam submerged spillway concrete shall be inspected at an inspection interval not to exceed 10 years. Results of these inspections shall be	implementation. Determine the overall status of committed actions. Review and incorporate applicable operating experience into the implementation of the assigned aging management program or commitment. RNP is currently over 2 years into the period of extended operation, and 3 years from the last self-assessment (AR 363854). Another driver for this quick hit self-assessment is an upcoming NRC audit of license renewal related aging management programs. Due to resource limitations, this quick hit self-assessment reviewed only a sample of the aging management programs, selecting AMPs based on the prioritization list provided by the NRC audit team. The following AMPs were reviewed, and their program owners interviewed: Nickel Alloy Nozzles and Penetrations Fire Protection and Fire Water Programs Dam Inspection Program Steam Generator Tube Integrity Bus Duct Aging Management Program Fatigue Monitoring Program Open Cycle Cooling Water Program Preventive Maintenance Program Boric Acid Corrosion Program Flow Accelerated Corrosion Program Reactor Vessel Internals Program Even though not all AMP programs were covered in the quick self-assessment, the RNP periodic self-assessment of AMP is a good practice, and is recommended to all applicants. 4. The program enhancement requires that the Lake Robinson Dam shall be monitored for loss of form due to

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	reviewed by the Responsible Engineer for the Lake Robinson Dam, and corrective actions initiated for any unacceptable attributes. The Lake Robinson Dam shall be monitored for loss of form due to settlement.	settlement. Verify the results of monitoring of loss of form due to settlement. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): GALL states that, in general, all structures and ground water quality are monitored on a frequency not to exceed 5 years. It is recommended to increase the frequency of ground water sampling in GALL from "not to exceed 5 years" to "semi-annual" or "quarterly". ***Technical Basis*:** RNP performs periodic monitoring of below-grade water chemistry on a semi-annual basis for capturing potential seasonal variations to demonstrate that the below-grade environment is not aggressive.
5. Monitoring and Trending	The Recommended Guidelines for Safety Inspection of Dams, Phase I, Appendix I, investigation report instructs the user to review the "history of previous failures or deficiencies and pending remedial measures for correcting known deficiencies and the schedule for accomplishing remedial measures should be indicated". Additionally, a review of inspection history, including the results of the last safety inspection is recommended. Based on the meticulous requirements of the Phase I inspection and the documented history of independent inspections, monitoring and trending will provide predictability of the extent of degradation, and timely corrective or mitigation actions. The inspection interval for the Lake Robinson dam is five years. The inspection interval for the submerged spillway concrete started in 2000 and will not exceed (10) ten years. Aging Management Commitment #27 includes: "Establish trending requirements for structures based on	Verify the trending results of the ground water and lake water on increasing aggressiveness. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): (1) Use "increasing aggressiveness of the groundwater/lake water" as a leading indicator in GALL for potential degradation to below grade concrete structures, because Increasing aggressiveness of the groundwater/lake water would indicate potential degradation for all below-grade concrete structures in LR scope. (2) Use "degradation to below-grade concrete exposed during excavation" as a leading indicator for potential degradation to remaining below grade concrete structures, because Degradation to below-grade concrete exposed during excavation would indicate potential degradation to remaining below grade concrete structures.

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	aggressive ground water and lake water". RNP implements the trending and evaluation of lake water and ground water in following requirements in EGR-NGGC-0351: - Degradation to submerged concrete observed during periodic under water inspections at the Intake Structure and RNP Dam Spillway will be used as a leading indicator for potential degradation to below grade concrete structures in the scope of License Renewal. - Degradation to below grade concrete exposed during excavation will be used as a leading indicator for potential degradation to remaining below grade concrete structures in the scope of License Renewal. -Groundwater and lake water monitoring results (pH, chlorides, sulfates) will be reviewed by Engineering and trended. Increasing aggressiveness of the groundwater and lake water will be used as a leading indicator for potential degradation to below grade concrete structures in the scope of License Renewal. - Engineering will evaluate if the leading indicators for potential degradation to concrete are common to other structures in the scope of License Renewal (including ASME Section XI, Subsection IWL), and shall initiate appropriate corrective actions.	
6. Acceptance Criteria	Acceptance criteria for the inspection and monitoring of Lake Robinson Dam are in accordance with the requirements of the "Recommended Guidelines for Safety Inspection of Dams." As such, the acceptance criteria will ensure the structure or component intended function(s) are maintained under all CLB design conditions during the period of extended operation.	No significant issue or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
7. Corrective Actions	The inspection guidelines implement a two phased approach, Phase I performs a detailed field inspection. The Phase II investigation is supplementary to Phase I and is conducted when the results of the Phase I investigation indicate the need for additional in-depth studies, investigations, or analyses. The Program will be enhanced by revising the plant system monitoring procedure, to identify the "Recommended Guidelines for Safety Inspection of Dams" as the required management program, and requiring the responsible system engineer to review the inspection report, and initiate corrective actions for any unacceptable attributes identified during the inspection process. Program Enhancement: Revise the System Walkdown Procedure (TMM-104) to identify the "Recommended Guidelines for Safety Inspection of Dams" as the required management program for the H.B. Robinson Dam, and require the responsible system engineer to review the report, and initiate corrective actions for any unacceptable attributes identified during the inspection process. Also, add a trending section to TMM-104 to require degradation to submerged concrete observed during periodic under water inspections at the Dam Spillway to be used as a leading indicator for potential degradation to other below grade concrete structures in the scope of LR.	No significant issue or further review item was identified.
8. Confirmation Process	The subject program is condition monitoring rather than preventative; however, based on the Guideline requirements to review the history of previous dam inspections, degraded components are re-evaluated to confirm the effectiveness of the recommended actions. A two-phased methodology is used in the program; therefore, degradation exceeding the threshold of a Phase I inspection will require the responsible engineer to initiate	N/A – this is boilerplate and items of concern are not expected for this element.

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	corrective actions, and potentially require a Phase II inspection, based on the type and extent of degradation observed.	
9. Administrative Controls	Corporate and Site Quality Assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50, and will continue to be adequate for the period of extended operation.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	The Lake Robinson Dam is an RNP Unit 1 (Fossil Plant) structure and therefore not typically subject to the corrective action process required for nuclear plant systems and structures. As such, the normal source of operating experience is not populated. However, five dam inspection reports, dating back to 1980 on five-year intervals from 2000, have been reviewed. Recommendations are made in each report and photographs were taken of typical areas and areas of concern. In addition, a sample of CP&L Unit 1 dam bi-monthly visual inspection reports, yearly DHEC dam inspection reports, and a year 2000 underwater visual inspection report of the spillway were reviewed. Also, monthly testing of the valves and gates is performed by Unit 1 personnel and corrective actions are taken as necessary. No significant issues have been identified; however, recommended maintenance activities have been performed, as evidenced by succeeding inspection reports. For example: The 1980 report recommends cutting trees on the downstream slope, removing the root system, and filling in the holes; a photograph was taken of the subject area showing the trees. The 1985 report notes in the conclusions the downstream grass cover is well established and aerial photos show no trees on the	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs** (as result of audit): 1. Consider NRC NUREG-1522 for OE. It describes instances of, and corrective actions for, severely degraded steel and concrete components at the intake structure and pump house of coastal plants, as well as appreciable leakage from the spillway gates, concrete cracking, corrosion of spillway bridge beam seats and cooling canal, and appreciable differential settlement. 2. In the next GALL update, consider including Rev. 2 of RG 1.127 in XI.S6. It provides a summary of the main causes of dam failures, and suggestions for preventive measures. 3. The inspection results described in the RNP SER may be included in the GALL update. For example, divers performed an underwater inspection of the dam spillway on June 20, 2000. The spillway inspection examined the condition of concrete, especially at the tainter gates. A spalled portion of concrete (6' by 8" by 4" deep) was identified. This area is scheduled for re-inspection and repaired, prior to the period of extended operation. The Dam Inspection Program will monitor the condition of the normally inaccessible submerged spillway concrete surfaces at a frequency not to exceed 10 years. No other underwater concrete degradation was identified.

Program Element	Element of Licensee's AMP (LRA Section B.3.16)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	downstream slope. The year 2000 underwater visual inspection report of the submerged concrete spillway identified a spalled portion of concrete, which needed repair. This repair is scheduled for completion in 2003.	

B.29.4. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.29.5. Documents Reviewed during the Audit

1. AR 363854
2. ASTM A325
3. ASTM A490
4. ASTM F1852
5. Aging Management Commitment Resolution for the Dam Inspection Program.
6. CAP-NGGC-0201-5-18, Rev. 18, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, Nov. 26–28, 2012.
7. EGR-NGGC-0351, Rev. 18, Conditions Monitoring of Structures.
8. EGR-NGGC-0512, Rev. 6, License Renewal Aging Management Activities.
9. EGR-NGGC-0514, Rev. 1, License Renewal Implementation Procedure
10. EPRI NP-5067
11. EPRI NP-5769
12. EPRI TR-104213
13. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
14. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
15. NUREG-1339
16. NUREG-1522

17. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
18. RCSC (Research Council for Structural Connections), Specification for Structural Joints Using ASTM A325 or A490 Bolts
19. RG 1.127
20. RNP-L/LR-0636, Rev. 5, Aging Management Program, Recommended Guidelines for Safely Inspection of Dams.
21. Recommended Guidelines for Safety Inspection of Dams, Department of Army, Office of Chief of Engineers, Sept, 1979
22. TMM-104, System Walkdown Procedure.

B.29.6. Summary

The Dam Inspection AMP is a plant-specific AMP for managing aging effects of Lake Robinson dam. Lake Robinson was constructed originally as a cooling water source for the Robinson Unit 1 fossil station. The lake was created by construction of the Lake Robinson Dam. The dam includes a reinforced concrete spillway. Two large steel gates and steel valves used to control water release from the reservoir. Lake Robinson reservoir provides plant cooling water and fire protection water.

The FERC/US Army Corp of Engineers program, “Recommended Guidelines for Safety Inspection of Dams,” is credited by RNP for the aging management of the Lake Robinson earthen dam and associated concrete structures. GALL Rev. 2 states that:

> For dam inspection and maintenance, programs under the regulatory jurisdiction of the Federal Energy Regulatory Commission (FERC) or the U.S. Army Corps of Engineers, continued through the period of extended operation, are adequate for the purpose of aging management. For programs not falling under the regulatory jurisdiction of FERC or the U.S. Army Corps of Engineers, the staff evaluates the effectiveness of the aging management program (AMP) based on compatibility to the common practices of the FERC and Corps programs.”

In any case, the reviewer determined that the FERC/US Army Corp of Engineers program is an acceptable method documented in GALL for managing aging effects of Lake Robinson dam.

The following items were noted in the audit,

1. The reviewer noted that the AMP identifies loss of form due to settlement for earthen structures aging effects/mechanisms. This may not be adequate.

For earthen structures: Settlement, depressions, sink holes, slope stability (e.g., irregularities in alignment and variances from originally constructed slopes), seepage, proper functioning of drainage systems, and degradation of slope protection features such as rip rap, longitudinal and transversal cracks, scour, rodent activity (animal burrows), slumps, boils, and vegetation control can be included as Aging Effects/Mechanisms for earthen structures

2. The AMP specifies that inspection frequency of the submerged spillway concrete is not to exceed ten years in the period of extended operation. The submerged spillway was inspected on June, 2000. Divers performed an underwater inspection. A spalled portion of concrete (6' by 8" by 4" deep) was identified. The area was repaired prior to the period of extended operation. Reg. Guide 1.127 and GALL AMP XI.S7 described periodic inspection of the water controlled structures at least once every 5 years. The 10-year inspection interval for the submerged spillway concrete should be justified.

3. NRC RG 1.127 and GALL XI.S7 describe special inspections immediately following the occurrence of significant natural phenomena, such as large floods, earthquakes, hurricanes, tornadoes, and intense local rainfalls. It was not clear whether the RNP AMP includes such special inspections. During the audit, RNP engineer clarified that inspections were conducted after major rainfall; no CR has been created from the inspections.

4. The ground water at the dam site is monitored twice a year, by a private company.

5. The state conducts yearly inspections, aside from the inspections performed by RNP in accordance with the dam inspection AMP.

6. RNP also performs routine bimonthly inspection on structures, and monthly inspection on mechanical systems.

B.30 X.E1 (TLAA) Environmental Qualification of Electrical Equipment

B.30.1. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's TLAA (LRA Section 4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The RNP environmental Qualification (EQ) program maintains the qualified life of electrical equipment important to safety within the scope of 10 CFR 50.49, "Environmental Qualification of Electrical Equipment Important to safety for Nuclear Power Plants." An aging limit (qualified life) is established for equipment within the scope of the RNP EQ program, and an appropriate action, such as replacement or refurbishment, is taken prior to, or at the end of, the equipment qualified life, such that the aging limit is not exceeded. Environmental qualification binders are maintained to demonstrate and document the qualified life of the equipment. The RNP program activities establish, and demonstrate, the level of qualification, qualified configuration, maintenance, surveillance, and replacement requirements necessary to meet the requirements of 10 CFR 50.49. The RNP EQ program includes maintenance of supporting documentation, such as input information, references, calculation, analyses, EQ related correspondence, qualification test report, and certifications.	The applicant's LRA, Appendix B, initially did not include the existing aging management program for environmental qualification. An evaluation of the existing EQ program only included time limited aging analysis. By RAI response, the applicant added AMP B.2.9, Environmental Qualification (EQ) of Electrical Components. Program description for B.2.9 lacks the detail of GALL Report AMP X.E1, but no significant concern or further review items were identified for the applicant's EQ program description.
1. Scope of Program	The RNP EQ program includes certain electrical components that are important to safety and could be exposed to harsh environment accident conditions, as defined in 10 CFR 50.49.	No significant concern or further review items were identified.

Program Element	Element of Licensee's TLAA (LRA Section 4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
2. Preventive Actions	10 CFR 50.49 does not require actions that prevent aging effects. The RNP EQ program actions that could be viewed as preventive actions include (a) establishing the component service condition tolerance and aging limits (for example, qualified life or condition limit), (b) refurbishment, replacement, or requalification of installed equipment, prior to reaching these aging limits, and (c) where applicable, requiring specific installation, inspection, monitoring, or periodic maintenance actions, to maintain equipment aging effects within the qualification.	No significant concern or further review items were identified.
3. Parameters Monitored/ Inspected	EQ component aging limits are not typically based on condition or performance monitoring. However, per Regulatory Guide 1.89, Rev. 1, such monitoring programs are an acceptable basis to modify aging limits. Monitoring or inspection of certain environmental, condition, or equipment parameters may be used to ensure that the equipment is within its qualification, or as a means to modify the qualification.	No significant concern or further review items were identified.
4. Detection of Aging Effects	10 CFR 50.49 does not require the detection of aging effects for in-service components. Monitoring of aging effects may be used as a means to modify component aging limits.	No significant concern or further review items were identified.
5. Monitoring and Trending	10 CFR 50.49 does not require monitoring and trending of component condition or performance parameters of in-service components to manage the effects of aging. EQ program actions that could be viewed as monitoring include monitoring how long qualified components have been installed. Monitoring or inspection of certain environmental, condition, or component parameters may be used to ensure that a component is within its qualification, or as a means to modify the qualification.	No significant concern or further review items were identified.

Program Element	Element of Licensee's TLAA (LRA Section 4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
6. Acceptance Criteria	10 CFR 50.49 acceptance criteria are that an in-service EQ component is maintained within its qualification including: (a) Its established aging limits and (b) continued qualification for the projected accident conditions. 10 CFR 50.49 requires refurbishment, replacement, or requalification, prior to exceeding the aging limits of each installed device. When monitoring is used to modify a component aging limit, plant-specific acceptance criteria are established based on applicable 10 CFR 50.49(f) qualification methods.	No significant concern or further review items were identified.
7. Corrective Actions	Corrective actions, including root cause determinations and prevention of recurrence, are done in accordance with the Corrective Action Program. Timeliness of corrective action is monitored.	Corrective action for B.2.9 lacks the detail of GALL Report AMP X.E1, but no significant concern or further review items were identified for the applicant's EQ program corrective action.
8. Confirmation Process	Effectiveness of this AMP will be monitored using Corrective Action Program and quality assurance procedures, review and approval processes, and administrative controls, which are implemented in accordance with the requirements of 10 CFR 50, Appendix B.	No significant concern or further review items were identified.
9. Administrative Controls	Corrective action and quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR 50, and will continue to be adequate for the period of extended operation.	No significant concern or further review items were identified.
10. Operating Experience	The RNP EQ program includes consideration of operating experience to modify qualification bases and conclusions, including aging limits. Compliance with 10 CFR 50.49 provides evidence that the component will perform its intended functions during accident conditions, after experiencing the detrimental effects of	No significant concern or further review items were identified.

Program Element	Element of Licensee's TLAA (LRA Section 4.4)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	in-service aging.	

B.30.2. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

7) Methodologies used to establish or evaluate an EQ component's qualified life, or to project qualified life and LOCA for subsequent license renewal performance, should be reviewed to confirm applicability, and that adequate margin is maintained.
8) The use of plant data (temperature and radiation), instead of design values, and the methodology used to acquire and evaluate these parameters, varies by applicant.
9) For subsequent license renewal (60 to 80 years), establish that current methods to project qualified life and ensure LOCA EQ for electrical components provide adequate margin, or maintain EQ for PEO.
10) It may be useful to determine if there were any major plant modifications, or events of sufficient duration, to cause the temperature and radiation values used in the underlying assumptions in the EQ calculations to be exceeded.
11) An evaluation that addresses the controls used to monitor changes in plant environmental conditions, to periodically validate the environmental data used in analyses.
12) Wear cycle aging may be a factor for some equipment within the EQ program. A wear cycle aging effect may be applicable to motors, limit switches, and connectors, and other electrical components for the period of extended operation.

ACTION ITEM for Consideration for writing SLR-GDs (as result of audit): Consider the above six items for the TLAA in general. These issues should be considered in the context of SLR.

B.30.3. Documents Reviewed during the Audit

1. 10 CFR 50.49, Environmental Qualification of Electrical Equipment Important to safety for Nuclear Power Plants.
2. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
3. CAP-NGGC-0201-7-17, Fire Protection Program Self-Assessment 2012, April, 2012.
4. CAP-NGGC-0201-8-17 (nonpublic), Quick Hit Self-Assessment, Potential Trend Assessment, INPO Assist Visit, Dec. 12, 2011.

5. EC 51573, Rev. 4, Engineering Change, Acceptance, Approval and Issue of EQ related Documents based on a qualified life of 60 years and Appendix K power uprate.
6. EDP-2.1, Rev. 9, Environmental Qualification Documentation Package, Limitorque Motor Operated Valve Actuators with Reliance Class H, Type RH Motors for Inside CV Application.
7. EGR-NGGC-0156, Rev. 16, Environmental Qualification of Electrical Equipment Important to Safety.
8. EGR-NGGC-0512, Rev. 6, License Renewal Aging Management Activities.
9. EGR-NGGC-0514, Rev. 1, License Renewal Implementation Procedure
10. EQDP 30, EQ Calculation, Rockbestos EQ Cable Aging Basis.
11. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
12. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
13. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
14. NUREG-1801, Rev. 0, Generic Aging Lessons Learned (GALL) Report, April 2001.
15. NUREG-1801, Rev. 1, Generic Aging Lessons Learned (GALL) Report, December 2010.
16. Program Health Report, Electrical Systems, 7/1/2012 – 9/30/2012
17. RAI, Response to, Robinson, Unit 2, Regarding Application for Renewal of Operating License - Attachment III, 4/28/2003.
18. RG 1.89, Rev. 1
19. RNP-L/LR-0390, Rev. 4, Aging Management Review of Electrical Commodities for License Renewal.
20. RNP-L/LR-0390, Rev. 4, Attachment X: License Renewal Aging Management Program for Non-EQ Electrical Cables Used in Instrumentation Circuits.
21. RNP-L/LR-0394, Rev. 1, Environmental Qualification for Electrical Equipment Program Review for License Renewal.
22. TMM-036, Rev. 36, Environmentally Qualified Electrical Equipment Required Maintenance.

B.30.4. Summary

The RNP environmental qualification (EQ) program maintains the qualified life of the electrical equipment important to safety within the scope of 10 CFR 50.49, “Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants." An aging limit (qualified life) is established for equipment within the scope of the RNP EQ program, and an appropriate action, such as replacement or refurbishment, is taken prior to, or at the end of, the equipment qualified life, such that the aging limit is not exceeded.

The RNP EQ program activities establish, demonstrate, and document the level of qualification, qualified configuration, maintenance, surveillance, and replacement requirements necessary to meet the requirements of 10 CFR 50.49. The RNP EQ program includes maintenance of supporting documentation, such as input information, references, calculations, analyses, EQ related correspondence,

qualification test reports, and certifications. Environmental qualification binders are maintained to demonstrate and document the qualified life of the equipment.

In the LRA Section 4.4, the applicant stated that “thermal, radiation, and wear cycle aging analyses of electrical and I&C components, required to meet 10 CFR 50.49, have been identified as time-limited aging analyses for RNP. Moisture (humidity and submergence) was not identified as an environmental stressor.

The EQ rule (10 CFR 50.49) identifies the six environmental conditions that must be included to establish qualification as: (1) Temperature, (2) pressure, (3) humidity, (4) radiation, (5) chemicals, and (6) submergence. "Moisture" would be covered by humidity and submergence.

In LRA Section 4.4, the applicant stated that the Environmental Qualification Program manages component thermal, radiation, and wear cycle aging, through the use of aging evaluations based on 10 CFR 50.49(f) qualification methods. Appendix B, Aging Management Programs did not include an Environmental Qualification Program as one of the existing aging management programs. The applicant added Section B.2.9, “Environmental Qualification (EQ) of Electric Equipment” to resolve the discrepancy.

In the LRA Section 4.4.1, the applicant stated that temperature and radiation values assumed for service conditions in the environmental qualification analyses are either the design operating values or measured values for Robinson Nuclear Plant (RNP).

The temperature and radiation values used for service conditions in the environmental qualification analyses discussed in LRA Section 4.4.1 are either the design values or are based on measured values. Design values are based on plant design documentation that supports the current licensing basis, including the UFSAR, design calculations, and EQ program evaluations. Measured values are actual measured values taken over a period of one or more years.

The LRA did not address whether there have been any major plant modifications, or events at RNP of sufficient duration, to cause the temperature and radiation values used in the underlying assumptions in the EQ calculations to be exceeded. The LRA did not address the controls used to monitor changes in plant environmental conditions to periodically validate the environmental data used in analyses. Supporting information was provided by the applicant.

B.31 XI.E1 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (LRA Section B.4.6)

B.31.1. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (LRA Section B.4.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The Non-EQ Insulated Cables and Connections Aging Management Program is a condition monitoring program designed to provide reasonable assurance that age-related degradation will not inhibit the intended function of insulated cables and connectors, within the scope of license renewal, during the period of extended operation. The non-EQ insulated cables and connections managed by this program include those used in power, instrumentation, control and communication applications. The aging effects managed include embrittlement, discoloration, cracking, swelling or surface contamination leading to reduced insulation resistance, or electrical failure.	No significant concern or further review items were identified.
1. Scope of Program	The Non-EQ Insulated Cables and Connections Aging Management Program includes accessible (i.e. able to be approached and easily viewed) insulated cables and connections installed in structures (i.e. areas) within the scope of license renewal. This program includes cables and connections installed in an adverse, localized environment, caused by heat or radiation in the presence of oxygen, as well as other plant areas. An adverse, localized environment is defined as a condition in a limited plant area that is significantly more severe than the specified service condition for the cable or	No significant concern or further review items were identified. It is noted that moisture is not specified as an adverse localized environment, inconsistent with GALL revision 2. GALL Revision 2 – Description: An adverse localized environment exists based on the most limiting condition for temperature, radiation, or moisture for the insulation material of cables or connections.

Program Element	Element of Licensee's AMP (LRA Section B.4.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	connection.	
2. Preventive Actions	No actions are taken as part of this program to prevent or mitigate aging degradation.	No significant concern or further review item was identified.
3. Parameters Monitored/ Inspected	A representative sample of accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable and connection jacket surface anomalies, such as embrittlement, discoloration, cracking, swelling or surface contamination. Cable and connection jacket surface anomalies are precursor indications of conductor insulation aging degradation from heat or radiation in the presence of oxygen, and may indicate the existence of an adverse localized environment.	Program uses sampling which was removed in GALL Revision 2. However, implementation of this program essentially reviewed all accessible in-scope cable consistent with the aging effects identified in GALL Revision 2.
4. Detection of Aging Effects	Accessible insulated cables and connections installed in areas within the scope of license renewal will be inspected at least once every 10 years. Following issuance of a renewed operating license for RNP, the initial inspection will be completed before the end of the initial 40-year license term (July 31, 2010).	No significant concern or further review item was identified.
5. Monitoring and Trending	Trending of discrepancies will be performed as required in accordance with the RNP Corrective Action Program. Corrective action, as described in Chapter 17 of the RNP FSAR is implemented by the RNP Quality Assurance (QA) Program in accordance with 10 CFR 50, Appendix B.	No significant concern or further review item was identified.
6. Acceptance Criteria	The acceptance criterion is: No unacceptable visual indications of jacket surface anomalies, which suggest that conductor insulation applicable aging effects may exist, as determined by engineering evaluation. An unacceptable indication is defined as a noted condition or situation that, if left unmanaged, could lead to a loss	No significant concern or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	of the license renewal intended function.	
7. Corrective Actions	Engineering will perform an evaluation on accessible insulated cables and connections when the acceptance criteria are not met, in order to ensure that the license renewal intended functions will be maintained consistent with the current licensing basis. Such an evaluation is to consider the age and operating environment of the component, as well as the severity of the anomaly, and whether such an anomaly has previously been correlated to degradation of conductor insulation or connections. Corrective actions may include, but are not limited to, testing, shielding or otherwise changing the environment, relocation, or replacement of the affected cable or connection. Corrective actions (as required) will be implemented through the RNP Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B. When an unacceptable condition or situation is identified, a determination will be made, as to whether this same condition or situation could be applicable to other accessible or inaccessible insulated cables and connections.	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs (as result of audit):** Implementation of this AMP resulted in the identification of potential adverse localized environments in two areas, resulting in more frequent inspections planned for these areas.
8. Confirmation Process	The RNP Corrective Action Program will verify the effectiveness of corrective actions (as required). The confirmation process is considered an integral part of the Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	No significant concern or further review item was identified.
9. Administrative Controls	This program will be controlled by plant procedures. The administrative controls for these procedures are controlled by the Document Control Program. The	No significant concern or further review item was identified.

Program Element	Element of Licensee's AMP (LRA Section B.4.6)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Document Control Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	
10. Operating Experience	The OE review process is fully implemented at RNP and used to improve plant procedures and operating practices. This process will continue throughout the period of extended operation.	Not consistent with GALL Revision 2, in that operator experience is not discussed (plant and industry experience is not provided.)

B.31.2. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

1) Essentially, all accessible cables and connections in-scope are inspected. As a result, additional adverse localized environments therefore may be identified. GALL Revision 2 - a revision to include the identification of adverse localized environments should be evaluated.
2) Emphasis during AMP implementation appeared to be the inspection of cables with limited documentation on connection. GALL Revision 2 – is sufficient and provides adequate emphasis.

B.31.3. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. Assessment 311293-04, Quick Hit Self-Assessment Report, RNP Cable Aging Management, 11/12/2009.
3. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
4. CAP-NGGC-0200-10-28, Rev. 4, License Renewal Aging Management Program for Non-EQ Insulated Cables and Connections
5. CAP-NGGC-0201-8-17 508376-04, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, 3/20/2012.
6. CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.
7. EGR-NGGC-0108, Rev. 2, NGG Fleet Engineering Program: Cable Aging Management Program.
8. EGR-NGGC-0501, Rev. 13, Nuclear Plant License Renewal Program.
9. EGR-NGGC-0507, Rev. 3, Cable Aging Management Program.
10. EGR-NGGC-0512, Rev. 6, License Renewal Aging Management Activities.

11. EGR-NGGC-0514, Rev. 1, License Renewal Implementation Procedure
12. ESG 0007N, Rev. 4, Cable and Connections Inspection Training Guide.
13. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
14. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
15. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
16. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
17. NUREG-1801, Rev. 0, Generic Aging Lessons Learned (GALL) Report, April 2001.
18. NUREG-1801, Rev. 1, Generic Aging Lessons Learned (GALL) Report, December 2010.
19. PMR 494577, Preventive Maintenance – Cable and Connections.
20. Program Health Report, Cable Aging monitoring Program Q4-2012, 12/31/2012
21. RNP-L/LR-0390, Rev. 4, Aging Management Review of Electrical Commodities for License Renewal.
22. RNP-L/LR-0390, Rev. 4, Attachment X: License Renewal Aging Management Program for Non-EQ Electrical Cables Used in Instrumentation Circuits.
23. RNP UFSAR, Rev. 20, Ch. 18.
24. WO 01126106-01, Work Order Cable Walkdown Inspection Containment, 11/11/2008.
25. WO 01126106-02, Work Order Cable Walkdown Inspection Auxiliary Building, 12/16/2009.
26. WO 01126106-03, Work Order Cable Walkdown Inspection Turbine Building, 12/16/2009.

B.31.4. Summary

The Non-EQ Insulated Cables and Connections Aging Management Program is a condition monitoring program designed to provide reasonable assurance that age-related degradation will not inhibit the intended function of insulated cables and connectors within the scope of license renewal during the period of extended operation. The non-EQ insulated cables and connections managed by this program include those used in power, instrumentation, control and communication applications. The aging effects managed include embrittlement, discoloration, cracking, swelling or surface contamination leading to reduced insulation resistance, or electrical failure.

A representative sample of accessible electrical cables and connections installed in adverse localized environments are visually inspected for cable and connection jacket surface anomalies, such as embrittlement, discoloration, cracking, swelling or surface contamination. Cable and connection jacket surface anomalies are precursor indications of conductor insulation aging degradation from heat or radiation in the presence of oxygen, and may indicate the existence of an adverse localized environment.

Implementation of this AMP resulted in the identification of potential adverse localized environments in two areas, resulting in more frequent inspections planned for these areas. Potential adverse localized environments were identified in proximity to a cable raceway.

Program was not limited to sample area, but inspected all accessible cables in walkdown areas, including cables located in adverse localized environments and the identification of cables located in newly identified adverse localized environments. Greater scope than GALL Revision 2 – propose that XI.E1 be revised to ensure that adverse localized environments are identified for cable/connections. No cable degradation noted in documents reviewed. However, potential adverse environments identified (steam lines, high bay lighting) in proximity to cable tray and raceway were noted in photos taken during walkdowns. **ACTION ITEM for Consideration for writing SLR-GDs (as result of audit):**

B.32 XI.E02 Insulation Material for Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements Used in Instrumentation Circuits (Neutron Flux Instrumentation and High Range Radiation Monitoring Instrumentation Circuits) (Amended LRA Sections B.4.7 & B4.8)

B.32.1. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (Amended LRA Sections B.4.7 & 4,8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Exposure of electrical cables to adverse localized environments caused by heat, radiation, or moisture can result in reduced insulation resistance (IR). An adverse, localized environment is defined as a condition in a limited plant area that is significantly more severe than the specified service condition for the circuit. Reduced IR causes an increase in leakage currents between conductors and from individual conductors to ground. A reduction in IR is a concern for circuits with sensitive, low-level signals such as radiation monitoring and nuclear instrumentation, since it may contribute to inaccuracies in instrument circuits. The purpose of the aging management program described herein is to provide reasonable assurance that the intended function of radiation monitoring instrumentation circuits, exposed to an adverse localized environment caused by heat, radiation, or moisture, will be maintained consistent with the current licensing basis through the period of extended operation. In this aging management program, calibration results or findings of surveillance testing programs are used to identify the potential existence of aging degradation. For example, when an instrumentation circuit is found to be out of calibration, additional evaluation of the circuit is	No significant concern or further review item was identified. Program for instrument cable insulation was to be included in the scope of the non-EQ Insulated Cables and Connections program. By RAI response, the applicant implemented separate AMPs to manage the aging effects of neutron flux and high range radiation instrumentation circuits.

Program Element	Element of Licensee's AMP (Amended LRA Sections B.4.7 & 4,8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	performed. GALL AMP XI.E1 does not apply to the cables in these instrumentation circuits.	
1. Scope of Program	This is a program that applies to the non-EQ cables used in the source range, intermediate range, power range, and gamma-metrics instrumentation circuit of the excore nuclear instrumentation system, and another program that applies to the non-EQ cables used in CV high-range radiation monitoring instrumentation circuits.	No significant concern or further review item was identified.
2. Preventive Actions	No actions are taken as part of this program to prevent or mitigate aging degradation.	No significant concern or further review item was identified.
3. Parameters Monitored/ Inspected	Neutron Flux The parameters monitored include a loss of dielectric strength cause by thermal/thermo-oxidative degradation of organics or radiation-induced oxidation (radiolysis) of organics. High Range Radiation The parameters monitored are determined from the specific calibrations or surveillances performed, and are based on the specific instrumentation circuit under surveillance or being calibrated, as documented in plant surveillance calibration or surveillance procedures.	No significant concern or further review item was identified.
4. Detection of Aging Effects	Neutron Flux The cables used in neutron flux instrumentation circuits will be tested at least once every 10 years. Testing may include IR tests, time domain reflectometry (TDR) tests, I/V testing, or other testing judged to be effective in determining cable insulation condition. Following issuance of a renewed operating license for RNP, the first test will be completed before the end of the initial 40-year license term for RNP (July 31, 2010). High Range Radiation Review of calibration results or findings of surveillance	No significant concern or further review item was identified.

Program Element	Element of Licensee's AMP (Amended LRA Sections B.4.7 & 4,8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	programs can provide indication of aging effects by monitoring key parameters and providing data based on acceptance criteria related to instrumentation circuit performance. Reviews of results obtained during normal calibrations or surveillances may detect severe aging degradation prior to loss of cable intended function. The first reviews will be completed before the end of the initial 40-year license term for RNP (July 31, 2010), and every 10 years thereafter. All calibrations or surveillances that fail to meet acceptance criteria will be reviewed at the time.	
5. Monitoring and Trending	Neutron Flux Trending of discrepancies will be performed as required in accordance with the RNP Corrective Action Program. Corrective action, as described in Chapter 17 of the RNP UFSAR is part of the RNP Quality Assurance (QA) Program. High Range Radiation Trending actions are not included as part of this program, because the ability to trend test results is dependent on the specific type of test chosen. Trending of discrepancies will be performed as required in accordance with the RNP Corrective Action Program. Corrective action, as described in Chapter 17 of the RNP FSAR, is part of the RNP Quality Assurance (QA) Program.	No significant concern or further review item was identified.
6. Acceptance Criteria	Neutron Flux The acceptance criteria will be determined, based on the test selected for this program High Range Radiation Calibration results or findings of surveillances are to be within the acceptance criteria, as set out in the calibration or surveillance procedure.	No significant concern or further review item was identified.

Program Element	Element of Licensee's AMP (Amended LRA Sections B.4.7 & 4,8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
7. Corrective Actions	Neutron Flux Corrective actions (as required) are implemented through the RNP Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B. High Range Radiation Corrective actions such as recalibration and circuit trouble-shooting are implemented when calibration results or findings of surveillances do not meet the acceptance criteria. Corrective actions (as required) are implemented through the RNP Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	No significant concern or further review item was identified.
8. Confirmation Process	Neutron Flux The RNP Corrective Action Program will verify the effectiveness of corrective actions (as required). The confirmation process is considered an integral part of the Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B. High Range Radiation The RNP Corrective Action Program will verify the effectiveness of corrective actions (as required). The confirmation process is considered an integral part of the Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	No significant concern or further review item was identified.
9. Administrative Controls	Neutron Flux This program will be controlled by the Work Control Process. The administrative controls for Work Control Process are controlled by Document Control Program. The Document Control Program is implemented by the	No significant concern or further review item was identified.

Program Element	Element of Licensee's AMP (Amended LRA Sections B.4.7 & 4,8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	RNP QA Program in accordance with 10 CFR 50, Appendix B. High Range Radiation This program is implemented by surveillance test procedures as required by Plant Technical Specifications. The administrative controls for these procedures are controlled by the Document Control Program. The Document Control Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	
10. Operating Experience	Neutron Flux This program is for non-EQ neutron monitoring cabling systems. A review of site operating experience found no age related failures for neutron monitoring cables or connectors. However, Westinghouse Technical Bulletin 86-01 did not identify concerns with cables used for the source range detector, regarding cable degradation due to high operating voltage, radiation, heat, and moisture. Both the source range and intermediate range detector cables inside the containment were replaced in 1991, as a result of this technical bulletin. The replacement cables have remained functional during the last twelve years. The power range cables are the original installed cables, and are the same cable type (Ampheno/Essex 21-529) that was used for the source range and intermediate range circuits. The operating history for these cables demonstrates their reliability, and provides reasonable assurance that they will continue to perform their intended function throughout the period of extended operation. High Range Radiation Changes in instrument calibration data can be caused by	No significant concern or further review item was identified.

Program Element	Element of Licensee's AMP (Amended LRA Sections B.4.7 & 4,8)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	degradation of the circuit cable, and are a possible indication of potential cable degradation.	

B.32.2. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

None

B.32.3. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. AR 92139, License Renewal Transition Package Neutron Flux Instrumentation Cable AMP, 08/01/10.
3. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
4. CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.
5. CR 247492-31, Adverse Condition Investigation Form CAP-NGGC-0200-3-18.
6. CR 510234, Quick Cause Evaluation Report Form CAP-NGGC-0205-3-15, 1/20/12.
7. Commitment 37-2: Establish PM to use calibration or surveillance testing program data to identify the potential existence of aging degradation of R-32A and B on a 10 year frequency.
8. Commitment 137-1 Use calibration or surveillance test programs data to identify the potential existence of aging degradation of RS-32A and R-32B over past 10 years
9. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
10. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
11. IR 2010010, NRC Post-Approval Site Inspection for License Renewal Inspection Report, 05000261/2010010, June 2010.
12. LP-256, Rev. 13, Containment High Range Radiation Monitor (Area) RMS 32A and 32B.
13. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
14. NTM 92139-02, Summary of Commitment Implementation
15. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004

16. NUREG-1801, Rev. 1, Generic Aging Lessons Learned (GALL) Report, December 2010.
17. PM-496, Rev. 1, Source Range Cable/Connector/Detector Condition Monitoring (Shutdown).
18. PM-497, Rev. 1, Intermediate Range Cable/Connector/Detector Condition Monitoring (Shutdown).
19. PM-498, Rev. 2, Power Range Cable/Connector/Detector Condition Monitoring (Shutdown).
20. PMRQ 00010603, Conditioning Monitoring Data for N-31 (Source Range).
21. RAI 3.6.1-2, Response to, Regarding Application for Renewal of Operating License, 4/28/2003.
22. RNP-L/LR-0390, Rev. 4, Aging Management Review of Electrical Commodities for License Renewal.
23. RNP-L/LR-0390, Rev. 4, Attachment X: License Renewal Aging Management Program for Non-EQ Electrical Cables Used in Instrumentation Circuits.
24. RNP-RA/03-0031, Response to Request for Additional Information Regarding Application for Renewal of Operating License, 04/28/03.
25. RNP-RA/03-0103, Response to Open and Confirmation Items, 09/16/03.
26. RNP UFSAR, Rev. 20, Ch. 18.
27. Westinghouse Technical Bulletin 86-01

B.32.4. Summary

Neutron Flux

This program applies to the non-EQ cables used in the source range, intermediate range, power range, and gamma-metrics instrumentation circuits of the excore nuclear instrumentation system. Materials are various organic polymers. Aging effects include reduced insulation resistance due to thermal/thermo-oxidative degradation of organics, radiolysis, and photolysis (UV sensitive materials only) of organics; radiation-induced oxidation; and moisture intrusion.

The cables used in neutron flux instrumentation circuits will be tested at least once every 10 years. Testing may include insulation resistance (IR) tests, time domain reflectometry (TDR) tests, current voltage (I/V) testing, or other testing judged to be effective in determining cable insulation condition.

The aging management activity submitted by the applicant does not utilize the calibration approach for non-EQ electrical cables used in circuits with sensitive, low-level signals. Instead, these cables are simply combined with all other non-EQ cables under the visual inspection activity. The staff was concerned that visual inspection alone would not necessarily detect reduced insulation resistance (IR) levels in cable insulation before the intended function is lost. Therefore, the staff requested the applicant to provide a technical justification that will demonstrate that visual inspection will be effective in detecting damage, before current leakage can affect instrument loop

accuracy, or propose an alternate aging management activity (RAI 3.6.1-2). In response to the staff's above concern, the applicant implemented AMPs to manage the aging effects of neutron flux instrumentation circuits.

High Range Radiation

The aging management program provides reasonable assurance that the intended function of radiation monitoring instrumentation circuits exposed to an adverse localized environment caused by heat, radiation, or moisture will be maintained, consistent with the current licensing basis through the period of extended operation.

In this aging management program, calibration results or findings of surveillance testing programs are used to identify the potential existence of aging degradation. For example, when an instrumentation circuit is found to be out of calibration, additional evaluation of the circuit is performed. GALL AMP XI.E1 does not apply to the cables in these instrumentation circuits. **ACTION ITEM for Consideration for writing SLR-GDs** (**as result of audit)**

Program for instrument cable insulation was originally to be included in the scope of the non-EQ Insulated Cables and Connections program. By RAI response, the applicant implemented separate AMPs to manage the aging effects of high range radiation and neutron flux instrumentation circuits.

Cable system testing, as an alternative when the calibration or surveillance program does not include the cabling system in the testing circuit, was not selected by the applicant.

B.33 XI.E03 Inaccessible Power Cables Not Subject to 10 CFR 50.49 EQ Requirements (LRA Section N/A)

B.33.1. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	The purpose of the aging management program (AMP) described herein is to provide reasonable assurance that the intended functions of inaccessible or underground power cables that are not subject to the environmental qualification requirements of 10 CFR 50.49, and are exposed to wetting or submergence, are maintained consistent with the current licensing basis through the period of extended operation. Most electrical cables in nuclear power plants are located in dry environments. However, some cables may be exposed to wetting or submergence, and are inaccessible or underground, such as cables in conduits, cable trenches, cable troughs, duct banks, underground vaults, or directly buried in soil installations. When a power cable (greater than or equal to 400 volts) is exposed to wet, submerged, or other adverse environmental conditions, for which it was not designed, an aging effect of reduced insulation resistance may result, causing a decrease in the dielectric strength of the conductor insulation. This insulation degradation can be caused by wetting or submergence. This can potentially lead to failure of the cable's insulation system. In this AMP, periodic actions are taken to prevent cables from being exposed to significant moisture, defined as periodic exposures to moisture that last more than a few days (e.g., cable wetting or submergence in water).	The applicant states that no AMP is required for inaccessible medium-voltage (2 kV to 15 kV) cables (e.g., installed in conduit or direct buried) not subject to 10 CFR 50.49 EQ requirements. The applicant determined that there are no medium-voltage cables that are potentially susceptible to wetting that provide a license renewal intended function. In its review, the staff was concerned that some circuits (e.g., service water pumps) may be susceptible to wetting, and therefore an AMP is necessary. The staff requested the applicant, in RAI 3.6.1-4, to identify cables that are installed in conduits or direct buried, and explain how aging, due to wetting, will be managed. The applicant, in a letter dated April 28, 2003, stated that energized medium voltage cables are subject to a phenomenon known as water treeing, which can ultimately result in failure of the cable insulation. For the purposes of license renewal, medium-voltage is defined as 2 kV to 15 kV. According to the DOE/Sandia Aging management Guideline (SAND 96-0344), the incidence of cable failure due to water treeing has been found to be more prevalent as voltage level increases. The applicant evaluated all medium-voltage circuits to determine which in-scope components were fed by cables

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Examples of periodic actions are inspecting for water collection in cable manholes and conduits, and draining water, as needed. However, the above actions are not sufficient to ensure that water is not trapped elsewhere in the raceways. For example, (a) if a duct bank conduit has low points in the routing, there could be a potential for long-term submergence at these low points; (b) concrete raceways may crack due to soil settling over a long period of time; (c) manhole covers may not be watertight; (d) in certain areas, the water table is high in seasonal cycles, so the raceways may get refilled soon after purging; and (e) potential uncertainties exist with water trees even when duct banks are sloped with the intention to minimize water accumulation. Experience has shown that insulation degradation may occur if the cables are exposed to 100 percent relative humidity. The above periodic actions are necessary to minimize the potential for insulation degradation. In addition to the above periodic actions, in-scope power cables exposed to significant moisture are tested to indicate the condition of the conductor insulation. The specific type of test performed is determined prior to the initial test, and is to be a proven test for detecting deterioration of the insulation system due to wetting or submergence, such as Dielectric Loss (Dissipation Factor/Power Factor), AC Voltage Withstand, Partial Discharge, Step Voltage, Time Domain Reflectometry, Insulation Resistance and Polarization Index, Line Resonance Analysis, or other testing that is state-of-the-art at the time the tests are performed. One or more tests are used to determine the condition of the cables so they will continue to meet their intended function	installed as direct buried, in underground conduits, or in duct banks. Based on this review, the applicant found that there were no in-scope energized and wetted medium-voltage cables at RNP. The applicant stated that this aging mechanism (water tree) has not been observed in low-voltage cables, which are defined as cables rated at less than 2 kV. The staff concluded that the applicant provided adequate justification for not having an AMP for inaccessible medium-voltage cables not subject to 10 CFR 50.49 EQ requirements (based on GALL Revision 0). Subsequent to the Robinson license renewal, the staff, based on operating experience gained since GALL Revision 0, revised the GALL Report AMP XI.E3 as follows: GALL Report AMP XI.E3 Revision 2: 1. Removed the energized 25% of the time criterion 2. Revised inspections to at least once per year 3. Test Frequency revised to at least every 6 years 4. Add event driven inspections 5. Test results include reviews for consideration of more frequent testing 6. Inspection results are evaluated to determine the need for more frequent inspections The Robinson Cable Aging Management Program includes inaccessible medium voltage cables (circulating water pump motors (4.16kV). Based on testing performed under this program, the 2C circulating water pump cable was replaced. In addition, based on test results the 2C pump test frequency was revised to 3 years, instead of the program's 6 year frequency. The program is also stated to include actions and preventive maintenance to maintain

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	during the period of extended operation.	safety related and critical power cables from being in a submerged environment. Program heath reports reviewed by the staff have an overall status of red, based on not completing an assessment that all safety related cables and critical cables are being maintained in the environment for which they were qualified. Robinson received two non-cited violations for submerged cable issues.
1. Scope of Program	This AMP applies to all inaccessible or underground (e.g., in conduit, duct bank, or direct buried) power cables (greater than or equal to 400 volts) within the scope of license renewal exposed to adverse environments, primarily significant moisture. Significant moisture is defined as periodic exposures to moisture that lasts more than a few days (e.g., cable wetting or submergence in water). Submarine or other cables designed for continuous wetting or submergence are not included in this AMP.	Based on the gap analysis performed by RNP, the licensee added (although not credited for license renewal) 480 volt safety related buried cable for the Service water pumps and Diesel Generator fuel oil transfer pumps. Service water cable tests are performed on an 18 month frequency. The Diesel Generator fuel oil transfer pump motors are tested on a one year frequency. The associated manholes are inspected on a 6 month frequency. The applicant claimed that there are no gaps between Robinson's cable aging management program for inaccessible power cable and GALL Report XI.E3 Revision 2. Robinson stated in its industry OE evaluation (AR 545199) that the only underground medium voltage cables (circulating water pumps) are tested every 6 years, with the replacement of these cables scheduled. The low voltage power cable for the service water pumps have been replaced and installed in an above ground concrete cable tray. The diesel generator fuel oil transfer pump cables were replaced in 2003.
2. Preventive Actions	This is a condition monitoring program. However, periodic actions are taken to prevent inaccessible cables from being exposed to significant moisture, such as identifying and	Inspection frequencies at the plant are consistent with those recommended in NUREG-1801. Event driven inspections, inspection attributes, and dewatering systems

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	inspecting in-scope accessible cable conduit ends and cable manholes for water collection, and draining the water, as needed. The inspection frequency for water collection is established and performed, based on plant-specific operating experience with cable wetting or submergence in manholes (i.e., the inspection is performed periodically based on water accumulation over time and event driven occurrences, such as heavy rain or flooding). The periodic inspection should occur at least annually. The inspection should include direct observation that cables are not wetted or submerged, that cables/splices and cable support structures are intact, and that dewatering/drainage systems (i.e., sump pumps) and associated alarms operate properly. In addition, operation of dewatering devices should be inspected, and operation verified, prior to any known or predicted heavy rain or flooding events. If water is found during inspection (i.e., cable exposed to significant moisture), corrective actions are taken to keep the cable dry, and to assess cable degradation. The first inspection for license renewal is to be completed prior to the period of extended operation.	were not addressed in the GAP analysis.
3. Parameters Monitored/ Inspected	Inspection for water collection is performed, based on plant-specific operating experience with water accumulation in the manhole. Inaccessible or underground power (greater than or equal to 400 volts) cables within the scope of license renewal, exposed to significant moisture, are tested to provide an indication of the condition of the conductor insulation. The specific type of test to be used should be capable of detecting reduced insulation resistance of the cable's insulation system due to wetting or submergence.	No Program elements were available or reviewed for inaccessible power cables. Test frequencies consistent with GALL Report Revision 2
4. Detection of Aging Effects	For power cables exposed to significant moisture, test frequencies are adjusted, based on test results	No Program elements were available or reviewed for inaccessible power cables. Cable testing and frequency

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	(including trending of degradation where applicable) and operating experience. Cable testing should occur at least once every 6 years. A 6-year interval provides multiple data points during a 20-year period, which can be used to characterize the degradation rate. This is an adequate period to monitor performance of the cable, and to take appropriate corrective actions, since experience has shown that although a slow process, aging degradation could be significant. The first tests for license renewal are to be completed prior to the period of extended operation, with subsequent tests performed at least every 6 years thereafter. The applicant can assess the condition of the cable insulation with reasonable confidence using one or more of the following techniques: Dielectric Loss (Dissipation Factor/Power Factor), AC Voltage Withstand, Partial Discharge, Step Voltage, Time Domain Reflectometry, Insulation Resistance and Polarization Index, Line Resonance Analysis, or other testing that is state-of-the-art at the time the tests are performed. One or more tests are used to determine the condition of the cables, such that they will continue to meet their intended function during the period of extended operation	are consistent with the licensee's gap analysis
5. Monitoring and Trending	Trending actions are included as part of this AMP, although the ability to trend results is dependent on the specific type of test(s) or inspection chosen. Results that are trendable provide additional information on the rate of cable insulation degradation.	No Program elements were available or reviewed for inaccessible power cables.
6. Acceptance Criteria	The acceptance criteria for each test are defined by the specific type of test performed and the specific cable tested. Acceptance criteria for inspections of manholes are defined by the observation that the cables and support structures are not submerged or immersed in	No Program elements were available or reviewed for inaccessible power cables.

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	standing water at the time of the inspection.	
7. Corrective Actions	Corrective actions are taken and an engineering evaluation is performed, when the test or inspection acceptance criteria are not met. Such an evaluation considers the significance of the test or inspection results, the operability of the component, the reportability of the event, the extent of the concern, the potential root causes for not meeting the test or inspection acceptance criteria, the corrective actions required, and the likelihood of recurrence. When an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to other accessible or inaccessible, in-scope power cables. Corrective actions may include, but are not limited to, installation of permanent drainage systems, installation of sump pumps and alarms, more frequent cable testing or manhole inspections, or replacement of the affected cable. As discussed in the appendix to thisTLR, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.	No Program elements were available or reviewed for inaccessible power cables. Corrective actions were noted in the gap analysis and self-assessments.
8. Confirmation Process	As discussed in the appendix to thisTLR, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	The administrative controls for this AMP provide a formal review and approval process. As discussed in the appendix to the report, the staff finds the requirement of 10 CFR Part 50, Appendix B, acceptable to address administrative controls.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	Operating experience has shown that insulation materials are susceptible to water tree formation. The formation and growth of water trees varies directly with operating voltage. Aging	No Program elements were available or reviewed for inaccessible power cables.

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	effects of reduced insulation resistance due to other mechanisms may also result in a decrease in the dielectric strength of the conductor insulation. Minimizing exposure to moisture mitigates the potential for the development of reduced insulation resistance. Recent incidents involving early failures of electric cables and cable failures leading to multiple equipment failures, are cited in NRC IN 2002-12, "Submerged Safety-Related Cables," and NRC GL 2007-01, "Inaccessible or Underground Power Cable Failures That Disable Accident Mitigation Systems or Cause Plant Transients." The NRC issued GL 2007-001 on inaccessible or underground cables to (a) inform licensees that the failure of certain power cables can affect the functionality of multiple accident mitigation systems or cause plant transients and (b) gather information from licensees on the monitoring of inaccessible or underground power cable failures for all cables that are within the scope of the Maintenance Rule. Based on the review of licensees' responses, the NRC staff has identified 269 cable failures for 104 reactor units. The data obtained from the GL responses show an increasing trend of cable failures. The NRC staff has noted that the predominant factor contributing to cable failures at nuclear power plants was due to moisture/submergence. The staff also noted that the GL failure data show that the majority of the reported failures occurred at the 4160-volt, 480 volt, and 600-volt service voltage levels, for both energized and de-energized cables. These cables are failing within the plants' 40-year licensing period. The NRC inspectors also have continued to identify safety-related cables which are submerged. The staff noted that licensees had not demonstrated that the subject safety-related cables were designed for wetted or submerged service for the current license period. This AMP considers the technical information and generic communication guidance provided in NUREG/CR-5643; IEEE Std. 1205-2000; SAND96-0344; EPRI 109619; EPRI 103834-P1-2; NRC IN 2002-12; NRC GL 2007-01; NRC GL 2007-01 Summary Report; NRC Inspection Procedure, Attachment 71111.06,	Low voltage inaccessible power cables were added to the cable aging management program. Industry OE evaluated.

Program Element	Element of GALL Rev. 2 AMP XI.E3 (Licensee AMP - N/A GALL Rev. 0)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Flood Protection Measures; NRC Inspection Procedure, Attachment 71111.01, Adverse Weather Protection; RG 1.211 Rev 0; DG-1240; and NUREG/CR-7000.	

B.33.2. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

N/A

B.33.3. Documents Reviewed during the Audit

1. 10 CFR 50.49, Environmental Qualification of Electrical Equipment Important to safety for Nuclear Power Plants.
2. AR 476676, Water Present in Manholes, 7/14/2011.
3. AR 545199, IER Level 2 Document Evaluation, Electrical Faults Cause Two Reactor Scrams (Industry OE Review), 6/19/2012.
4. AR 572847-19, Gap Analysis
5. Assessment 311293-04, Quick Hit Self-Assessment Report, RNP Cable Aging Management, 11/12/2009.
6. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
7. EPRI 103834-P1-2
8. EPRI 109619
9. GL 2007-01, Inaccessible or Underground Power Cable Failures That Disable Accident Mitigation Systems or Cause Plant Transients
10. IEEE Std. 1205-2000
11. IN 2002-12, Submerged Safety-Related Cables.
12. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
13. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
14. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
15. NRC Inspection Procedure, Attachment 71111.01, Adverse Weather Protection
16. NRC Inspection Procedure, Attachment 71111.06, Flood Protection Measures

17. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
18. NUREG/CR-5643
19. NUREG/CR-7000
20. Program Health Report, Cable Aging monitoring Program Q4-2012, 12/31/2012
21. RG 1.211 Rev 0
22. RNP 508376-04, Cable Aging Management Program for RNP, 3/20/2012.
23. SAND 96-0344, Aging Management Guideline for Commercial Nuclear Power Plants, Electrical Cable and Terminations

B.33.4. Summary

No inaccessible medium voltage cables within scope.

Based on OE and regulatory issues, inaccessible medium and low voltage power cable were added to the Cable Aging Management Program. No corresponding AMP.

B.34 XI.E04 Metal-Enclosed Bus (Amended LRA Section B.4.10)

B.34.1. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (Amended LRA Section B.4.10)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected.	No significant concern or further review item was identified
1. Scope of Program	This program applies to the iso-phase bus as well as all non-segregated 4.16kV and 480V bus duct within the scope of license renewal.	The scope of program does not address the elastomers and the external of the bus ducts.
2. Preventive Actions	No actions are taken as part of this program to prevent or mitigate aging degradation.	No significant concern or further review item was identified.
3. Parameters Monitored/ Inspected	Bolted connections will be checked for loose connections by thermography, or by measuring connection resistance using a low range ohmmeter. Thermography will be performed while the bus is energized and loaded. Connection resistance measurements using a low range ohmmeter will be performed while the bus is de-energized, and shall consist of a sample of accessible bolted connections. This program will also inspect the bus duct for cracks, corrosion, foreign debris, excessive dust buildup, and evidence of water intrusion. The bus itself will be inspected for signs of cracking, corrosion, or discoloration, which may indicate overheating. The (internal) bus supports will be inspected for structural integrity and signs of cracks. Bus insulation will be visually inspected for signs of embrittlement, cracking, melting, swelling, or discoloration, which may indicate overheating or aging degradation.	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs (as result of audit)** All bolted connections should be inspected, instead of a sample of bolted connections. Visual inspection should be considered for uncovered bolted connection as well as resistance measurement or thermography. If thermography is considered, a window on the bus duct should be installed, because the cover of bus duct will mask any heat rise above the ambient temperature.
4. Detection of Aging Effects	This program will be completed before the end of the initial 40-year license term for RNP (July 31, 2010), and	**<u>ACTION ITEM</u> for Consideration for writing SLR-GDs (as result of audit):** All bolted connections should be

Program Element	Element of Licensee's AMP (Amended LRA Section B.4.10)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	every 10 years thereafter.	inspected instead of a sample of bolted connections. Visual inspection should be considered for uncovered bolted connection, as well as resistance measurement or thermography. If thermography is considered, a window on the bus duct should be installed, because the cover of bus duct will mask any heat rise above the ambient temperature. Step 8.2.6 of Procedure PM-013 states the following: "Based on the recommendations of the system engineer, perform inspections of bolted connections, including torque checks." The staff expressed concern to the applicant that re-torque is not recommended in the industry standard. The applicant-created CR 581783 states if an as-found torque reading is required, the bolt torque should be determined before loosening the bolt. After the torque check is performed on the bolt, the bolt nut and lock washer should be completely replaced. If the intent is to only ensure that the bolt is properly torqued, the bolt should be loosened and then torqued to the proper value. The applicant made this statement revision in all bus duct inspection procedures. The staff found the CR acceptable to address the staff's concern.
5. Monitoring and Trending	Trending actions are not included as part of this program. Trending will be performed as required in accordance with the RNP Corrective Action Program. Corrective action, as described in Chapter 17 of the RNP UFSAR, is part of the RNP Quality Assurance (QA) Program.	No significant concern or further review item was identified
6. Acceptance Criteria	If measuring connection resistance using a low range ohmmeter, micro-ohm values of accessible bolted	No significant concern or further review item was identified

Program Element	Element of Licensee's AMP (Amended LRA Section B.4.10)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	connections shall not exceed the high level of the normal range indicated in the manufacturer's published data. If manufacturer's data is not available, any accessible bolted connections must be within 25% of the lowest value of the other sample connections. If the thermal imaging test technique is used, the existing plant procedure defines the acceptance criteria. Also, the bus duct is to be free from unacceptable visual indications of surface anomalies, which suggest conductor insulation degradation. In addition, no unacceptable indication of corrosion, cracks, foreign debris, excessive dust buildup, or evidence of moisture intrusion is to exist. An unacceptable indication is defined as a noted condition or situation that, if left unmanaged, could lead to a loss of intended functions.	
7. Corrective Actions	Corrective actions (as required) are implemented through the RNP Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	No significant concern or further review item was identified
8. Confirmation Process	The RNP Corrective Action Program will verify the effectiveness of corrective actions (as required). The confirmation process is considered an integral part of the Corrective Action Program. The Corrective Action Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	The administrative controls for this program will be controlled by the Document Control Program. The Document Control Program is implemented by the RNP QA Program in accordance with 10 CFR 50, Appendix B.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	Industry experience has shown that failures have occurred, due to cracked insulation and moisture or debris buildup, internal to the bus duct. Experience has	No significant concern or further review item was identified

Program Element	Element of Licensee's AMP (Amended LRA Section B.4.10)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	also shown that buses exposed to appreciable ohmic heating or ambient heating during operation may experience loosening of bolted connections, related to the repeated cycling of connected loads, or of the ambient temperature environment. This phenomenon can occur in heavily loaded circuits (i.e., those exposed to appreciable ohmic heating or ambient heating) that are routinely cycled.	

B.34.2. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

All bolted connections should be inspected, instead of a sample of bolted connections. Visual inspection should be considered for uncovered bolted connection, as well as resistance measurement or thermography. If thermography is considered, a window on the bus duct should be installed, because the cover of bus duct will mask any heat rise.

B.34.3. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. AR 92147, License Renewal Transition Package Bus Duct Aging Management Program Commitment Tracking.
3. Aging Management Program for Bus Duct License Renewal Commitment Implementation, 10/18/12.
4. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
5. CR 581783
6. IP 710003, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report, April 12, 2010.
7. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
8. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
9. LRA, RNP Table 3.6-2 Electrical/I&C Aging Management Evaluation That are Different From or Not Addressed in the GALL Report

10. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
11. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric Plant, Unit 2 ADAMS ML040990702, March 2004
12. PM-013, Rev. 0, 480V NonSeg Bus Duct Inspection.
13. PM-128, Rev. 10, Main Generator Isophase Bus Duct Inspection.
14. PM-143, Rev. 9, Auxiliary Transformer Bus Duct Inspection.
15. PM-144, Rev. 11, Startup Transformer Bus Duct Inspection.
16. RAI 2.5.2-2, Response to, Regarding Application for Renewal of Operating License Pages 135-139 of 504, 4/28/03.
17. RNP-L/LR-0390, Rev. 4, Aging Management Review of Electrical Commodities for License Renewal.
18. RNP-L/LR-0390, Rev. 4, Attachment X: License Renewal Aging Management Program for Non-EQ Electrical Cables Used in Instrumentation Circuits.
19. SAND 96-0344, Aging Management Guideline for Commercial Nuclear Power Plants, Electrical Cable and Terminations

B.34.4. Summary

Bus ducts materials are various metal, porcelain, PVC, and silicone caulk. Aging effects of bus ducts include oxidation, loosening of bolted connections due to thermal cycling, and corrosion due to moisture.

A sample of accessible bolted connections will be checked for proper torque. This program also inspects the bus duct for cracks, corrosion, foreign debris, excessive dust buildup, and evidence of water intrusion. The bus itself will be inspected for signs of cracks, corrosion, or discoloration, which may indicate overheating. The internal bus supports will be inspected for structural integrity and signs of cracks.

The applicant removed the re-torque requirements after reviewing the staff's requested for additional information to other applicants. This practice is also consistent with GALL Rev. 2 AMP XI.E4.

In the original LRA, the applicant stated that based on the RNP AMR, no applicable aging effects were identified for the bus duct. Therefore, it was concluded that no aging management activities were required for the period of extended operation. The staff requested the applicant to explain why the connections (two end devices and intermediate points) will not require any aging management (RAI 2.5.2-2). These circuits may be exposed to appreciable ohmic or ambient heating during operation, and may experience loosening related to the repeated cycling of connected loads, or the ambient temperature environment (described in SAND 96-0344, Aging Management Guideline for Commercial Nuclear Power Plants – Electrical Cable and Terminations). In response to the staff's above concern, the applicant proposed an AMP for bus ducts (B.4.10) to manage the potential aging degradation of bolt loosening due to ohmic heating.

Commitment # 40 specified that prior to the period of extended operation, the AMP for Bus Ducts will be a new program that focuses on periodically inspecting the iso-phase bus duct, as well as all non-segregated 4.16 kV and 480V bus ducts, at least once every 10 years. At the time of 71003 Inspection (Post-Approval Site Inspection for License Renewal Inspection Report 05000261/2010010), this commitment item was partially completed, and additional tasks were pending to be implemented, prior to the period of extended operation. The inspectors reviewed the administrative control that was in place to track those pending actions, to verify that there was reasonable assurance that the applicant would complete the necessary actions to meet Commitment # 40.

The program did not appear consistent with GALL Rev. 2, with respect to elastomers and structural monitoring (external surfaces), as these were not specifically identified or not consistent with the GALL Rev. 2 program.

Visual inspection should be included as parts of inspection of bolted connection covered by heat shrink as well as uncovered bolted connections. The visual inspection could be used to detect broken washers, as well as corrosion of bolted connections

B.35 XI.E05 Fuse Holders (Amended LRA Section B.4.9)

B.35.1. Potential Items of Concern or Inadequacies of the AMP for Subsequent License Renewal Related to Specific Program Elements

Program Element	Element of Licensee's AMP (Amended LRA Section B.4.9)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
Program Description	Issues related to the program description are not expected.	No significant concern or further review item was identified
1. Scope of Program	This program applies to fuse holders located outside of active devices that have been identified as being susceptible to aging effects. Fuse holders inside an active device are not within the scope of this program.	No significant concern or further review item was identified
2. Preventive Actions	No actions are taken as part of this program to prevent or mitigate aging degradation.	No significant concern or further review item was identified
3. Parameters Monitored/ Inspected	This program will focus on the metallic clamp (or clip) portion of the fuse holder. The parameters monitored include thermal fatigue, in the form of high resistance caused by ohmic heating, thermal cycling or electrical transients, mechanical fatigue caused by frequent manipulation of the fuse itself or vibration, chemical contamination, corrosion, and oxidation.	No significant concern or further review item was identified
4. Detection of Aging Effects	Identified fuse holders within the scope of license renewal that are located outside of an active device will be tested at least once every 10 years. Testing may include thermography, contact resistance testing, or other appropriate testing to be determined prior to testing. Following issuance of a renewed operating license for RNP, the initial test will be completed before the end of the initial 40-year license term for RNP (July 31, 2010).	In addition to thermography or contact resistance, visual inspection should be included. Visual inspection can detect corrosion of fuse holders. **<u>ACTION ITEM</u> for Consideration for writing SLR-GDs (as result of audit):** Not currently addressed in GALL Rev. 2 XI.E5 element 4.
5. Monitoring and Trending	Trending of discrepancies will be performed as required in accordance with the Corrective Action Program. Corrective action, as described in Chapter 17 of the RNP UFSAR is part of the RNP Quality Assurance (QA)	No significant concern or further review item was identified

Program Element	Element of Licensee's AMP (Amended LRA Section B.4.9)	Potential AMP Items of Concern or Inadequacy for Subsequent Renewal
	Program.	
6. Acceptance Criteria	The acceptance criteria will be determined based on the test selected for this inspection program	No significant concern or further review item was identified
7. Corrective Actions	Corrective Actions Program will verify the effectiveness of corrective actions (as required). The confirmation process is implemented through the Corrective Action Program. The Corrective Action Program is implemented by the QA Program in accordance with 10 CFR 50, Appendix B.	No significant concern or further review item was identified
8. Confirmation Process	The RNP Corrective Action Program will verify the effectiveness of corrective actions (as required). The confirmation process is considered an integral part of the Corrective Action Program. The Corrective Action Program is implemented by the QA Program in accordance with 10 CFR 50, Appendix B.	N/A – this is boilerplate and items of concern are not expected for this element.
9. Administrative Controls	The administrative controls for this program will be controlled by the Work Control Process. The administrative controls for the Work Control Process are controlled by the Document Control Program. The Document Control program is implemented by the QA Program in accordance with 10 CFR 50, Appendix B.	N/A – this is boilerplate and items of concern are not expected for this element.
10. Operating Experience	Site specific and industry wide operating experience has shown that the loosening of fuse holders is an aging mechanism that, if left unmanaged, has led to a loss of electrical function continuity.	No significant concern or further review item was identified

B.35.2. Other concern related to the aging management for the subsequent license renewal period

(For example. lessons learned or corrective actions not directly related to the specific program elements mentioned above)

In addition to thermograph or contact resistance, visual inspection should be included. Visual inspection can detect corrosion of fuse holders. **ACTION ITEM for Consideration for writing SLR-GDs** (**as result of audit):** Maybe this should be in scope of program, as well as element 4

B.35.3. Documents Reviewed during the Audit

1. 10 CFR 50, Appendix B.
2. AR 92145, Commitment Tracking Fuse Holder Aging Management Program, 08/01/10.
3. Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
4. IR 2003009, H.B. Robinson Steam Electric Plant, NRC Inspection Report 50-261/03-09, June 2003.
5. IR 2010008, H.B. Robinson Steam Electric Plant, NRC Post-Approval Site Inspection for License Renewal, Inspection Report 05000261/2010008, February 2010.
6. LRA, Robinson Nuclear Plant License Renewal Application, 6/17/2002.
7. NUREG-1785, Appendix A of Safety Evaluation Report A-19.
8. NUREG-1785, Safety Evaluation Report Related to the License Renewal of H.B. Robinson Steam Electric.
9. NUREG-1801, Rev. 1, Generic Aging Lessons Learned (GALL) Report, December 2010.
10. RAI 2.5.2-1, Response to, Regarding Application for Renewal of Operating License, 4/28/2003.
11. RNP-L/LR-0390, Rev. 4, Aging Management Review of Electrical Commodities for License Renewal.
12. RNP-L/LR-0390, Rev. 4, Attachment X: License Renewal Aging Management Program for Non-EQ Electrical Cables Used in Instrumentation Circuits.
13. WO 01350429, Perform Thermography on DSDG Fuse
14. WO 01351332, Perform Thermography on DSDG Fuse, 6/20/09

B.35.4. Summary

Materials are metallic clamp (or clip) portion of the fuse holders. Aging effects include thermal fatigue in the form of high resistance caused by ohmic heating, thermal cycling or electrical transients, mechanical fatigue caused by frequent manipulation of the fuse itself or vibration, chemical contamination, corrosion, and oxidation.

Identified fuse holders within the scope of license renewal that are located outside of an active device will be tested at least once every 10 years. Testing may include thermography, contact resistance testing, or other appropriate methods to be determined prior to testing.

The staff issued RAI 2.5.2-1 to question the exclusion of fuse holders requiring AMR. The applicant added the fuse holder AMP to the LRA.

Commitment #39 specified that prior to the period of extended operation; the AMP for Fuse Holder is a new program, applicable to fuse holders located outside of active devices. The program utilizes thermography or other appropriate test methods to identify the potential existence of aging degradation. The program has a 10-year frequency.

Visual inspection should be included as part of inspection of fuse holders as well as thermography.

ACTION ITEM for Consideration for writing SLR-GDs (**as result of audit):** Maybe elaborate on the operating experience and scope of program, as well as element 4.

Appendix B Compilation of Supplemental References

(Alphabetical, specific to RNP and not included in comprehensive reference list, pg. 579)

ADM-NGGC-0104, Work Management Process
ADM-NGGC-0112, Rev. 5, Reactor Coolant System Material Integrity Management Program.
ADM-NGGC-0203, Rev. 18, Preventive Maintenance and Surveillance Testing Administration.
AP-022, Procedure Review, and Approval Process
AR 85018, License Renewal Commitment 35; Selective Leaching, Site Fire Protection System
AR 92139, License Renewal Transition Package Neutron Flux Instrumentation Cable AMP, 08/01/10.
AR 92145, Commitment Tracking Fuse Holder Aging Management Program, 08/01/10.
AR 92147, License Renewal Transition Package Bus Duct Aging Management Program Commitment Tracking.
AR 363854
AR 365673-09
AR 476676, Water Present in Manholes, 7/14/2011.
AR-508608-12
AR 545199, IER Level 2 Document Evaluation, Electrical Faults Cause Two Reactor Scrams (Industry OE Review), 6/19/2012.
AR 572847-19, Gap Analysis
Aging Management Commitment Resolution for the Dam Inspection Program.
Aging Management Program for Bus Duct License Renewal Commitment Implementation, 10/18/12.
Assessment 16681, Self-Assessment, October 2000
Assessment 311293-04, Quick Hit Self-Assessment Report, RNP Cable Aging Management, 11/12/2009.
Assessment 447056 (nonpublic), Robinson Secondary Chemistry Self-Assessment, 2011.
Assessment 447729, Buried Piping Self-Assessment 2012 (9/13/11 – 9/15/11), Sept. 2011.
Assessment 572847, Robinson Self-Assessment, November 26 – 28, 2012
Audit Report Related to the License Renewal Application for H. B. Robinson Steam Electric Plant, Unit 2, on May 28 and 29, 2003 (TAC NO. MB5223), ADAMS ML032250040, 8/12/2003.
Buried Piping and Tanks Surveillance Program Commitments, 2009.
CAP-NGGC-0200, Rev. 34, NGG Standard Procedure.
CAP-NGGC-0200-10-28, Rev. 4, License Renewal Aging Management Program for Non-EQ Insulated Cables and Connections
CAP-NGGC-0201, Self-Assessment Program.
CAP-NGGC-0201-5-18, LR Self-Assessment 2012, Nov. 2012.
CAP-NGGC-0201-5-18, Rev. 18, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, Nov. 26–28, 2012.
CAP-NGGC-0201-5-18, Rev. 18, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, Dec. 3, 2012.

CAP-NGGC-0201-7-17, Fire Protection Program Self-Assessment 2012, April, 2012.
CAP-NGGC-0201-8-17, Cranes Self-Assessment 2012 (January 27, 2012 – February 10, 2012), Feb. 8, 2012
CAP-NGGC-0201-8-17 (nonpublic), Quick Hit Self-Assessment, Potential Trend Assessment, INPO Assist Visit, Dec. 12, 2011.
CAP-NGGC-0201-8-17 508376-04, Quick Hit Self-Assessment, Potential Trend Validation, INPO Assist Visit, 3/20/2012.
CAP-NGGC-0202, Rev. 21, Operating Experience and Construction Experience Program.
CAP-NGGC-0202-7-20, Review of Monticello (Green Finding) Failure to Follow Fire Water Aging Management Program Implementing Procedure, Dec. 29, 2011.
CAP-NGGC-0205, Rev. 15, NGG Standard Procedure.
CAP-NGGC-0205-2-12, Fire water piping 2-FP-29 ruptured due to galvanic corrosion (Bruce Gerwe), Oct. 14, 2010.
CC N-481
CM-764, Rev. 13, Inspection and Repair of CV Liner and Insulation.
CP-001, Rev. 111, Plant Operating Manual, Vol. 5, Part 3, CP-001, Chemistry Monitoring Program.
CR 247492-31, Adverse Condition Investigation Form CAP-NGGC-0200-3-18.
CR 422782
CR-490939
CR 510234, Quick Cause Evaluation Report Form CAP-NGGC-0205-3-15, 1/20/12.
CR-532430
CR-532431
CR 581783
CR 95-0053.
CR 96-1803.
CR 98-0272.
CR 99-0196.
CR 99-02070, Assessment of Subsections IWE and IWL.
CR 99-02074, Assessment of plant procedure TMM-124, Inservice IWE/IWL Program.
CR AR 25444, Contaminants Found In Unit 1 Lighting Fuel Oil Tanks
Commitment 37-2: Establish PM to use calibration or surveillance testing program data to identify the potential existence of aging degradation of R-32A and B on a 10 year frequency.
Commitment 137-1 Use calibration or surveillance test programs data to identify the potential existence of aging degradation of RS-32A and R-32B over past 10 years.
EC 51573, Rev. 4, Engineering Change, Acceptance, Approval and Issue of EQ related Documents based on a qualified life of 60 years and Appendix K power uprate.
EC 52368, Access and inspection of CV Liner at Regenerative Heat Exchanger and Refueling Canal.
EC 65116, Cathodic Protection System Improvements.
EC 72699, Evaluation of Containment Building Liner, Insulation, Sheathing, and Coatings

EDP-2.1, Rev. 9, Environmental Qualification Documentation Package, Limitorque Motor Operated Valve Actuators with Reliance Class H, Type RH Motors for Inside CV Application.
EGR-NGGC-0005.
EGR-NGGC-0010, “System & Component Trending Program and System Notebooks
EGR-NGGC-0015, Rev. 4, Containment Inspection Program
EGR-NGGC-0026 (nonpublic), Rev. 3, System Walkdown Procedure.
EGR-NGGC-0108, Rev. 2, NGG Fleet Engineering Program: Cable Aging Management Program.
EGR-NGGC-0156, Rev. 16, Environmental Qualification of Electrical Equipment Important to Safety.
EGR-NGGC-0207 (nonpublic), Rev. 3, Corporate procedure for Boric Acid Corrosion Control.
EGR-NGGC-0211, Rev. 0, ASME Section XI Repair/Replacement Program
EGR-NGGC-0351, Rev. 18, Conditions Monitoring of Structures.
EGR-NGGC-0501, Rev. 13, Nuclear Plant License Renewal Program.
EGR-NGGC-0507, Rev. 3, Cable Aging Management Program.
EGR-NGGC-0512, Rev. 6, License Renewal Aging Management Activities.
EGR-NGGC-0514, Rev. 1, License Renewal Implementation Procedure
EQDP 30, EQ Calculation, Rockbestos EQ Cable Aging Basis.
ESG 0007N, Rev. 4, Cable and Connections Inspection Training Guide.
ESR 01-00195.
EST-064
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Westinghouse Technical Bulletin 86-01

Supplemental Information

Table B.1: Points of Contact at the Robinson Nuclear Plant

NRC Staff on Audit	Argonne Support	Industry Personnel
		Balakhnin, Vladislav
		Bardauskas, Tom
		Bennett
Bennett Brady	Omesh Chopra	Blew, Michael
		Brown, Kevin
John Burke	Dwight Diercks	Crabtree
Cliff Doutt	Yogen Garud	Doiron
Jim Gavula	David Ma	Erno
Allen Hiser		Flowers
		Hacking, Laurie
Amy Hull		Hendrickson
		Hightower, Richard
Bryce Lehman		Jackson
Seung Min		James, A.
		Lange, Jeff
Duc Nguyen		Ludwick
		Mallner, Chris
		Martrano, Dave
		Maysam, Al
NRC Staff at Headquarters		McCutcheon, Steve
Ganesh Cheruvenki		McFadyn, Joe
Kim Green		Moore, Ken
Bill Holston		Outlaw, Jason
Matt Homiack		Pizzuti, Greg
		Reimer, Jason
Chris Hunt		Snipes
Roger Kalikian		Spencer, Corey
		Starling
Jim Medoff		Stewart, Winston
Glenn Meyer		Stuckey
Kenn Miller		Thompson, Sarah
Ching Ng		Wallace, James
Aloysius Obodoaka		Watford
Jeff Poehler		
Pat Purtscher		
Abdul Sheikh		
Juan Uribe		

John Wise
Albert Wong
On Yee

Table B.2: H.B. Robinson AMPs and Corresponding GALL AMPs

Robinson AMP (see NUREG-1785, & Robinson LRA Appendix B)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	RNP POC
Neutron Flux Instrumentation Circuits	non-GALL	Cliff Doutt	Kenn Miller	-	Jackson
Dam Inspection (B3.16)	non-GALL/~XI. S6	John Burke	Juan Uribe	Dave Ma	Outlaw
System Monitoring (B3.17)	Plant specific	Bennett Brady	Kim Green	Dwight Diercks	McFadyn
Preventive Maintenance (B3.18)	Plant specific	Bennett Brady	Kim Green	Dwight Diercks	Stuckey
Metal Fatigue of Reactor Coolant Pressure Boundary (Fatigue Monitoring) (B3.19)	X.M1	Seung Min	Jim Medoff, Ching Ng, OnYee	Omesh Chopra	James
Non-EQ Insulated Cables and Connections (B4.6)	XI.E01	Duc Nguyen	Kenn Miller	-	Starling
Non-EQ Electrical Cables used in Instrumentation Circuits	XI.E02	Cliff Doutt	Kenn Miller	-	Bennett
Inaccessible Power Cables Not Subject to 10 CFR 50.49 EQ Requirements (B33)	XI.E03		Kenn Miller		
Bus Ducts	XI.E04	Duc Nguyen	Kenn Miller	-	Moore
Fuse Holders	XI.E05	Cliff Doutt	Kenn Miller	-	Starling
ASME Section XI, Subsections IWB, IWC, and IWD Inservice Inspection (B2.1.)	XI.M01	Allen Hiser		Yogen Garud	Blew, Michael
Water Chemistry (B2.2)	XI.M02	Amy Hull	Chris Hunt	Dwight Diercks	Spencer
Reactor Head Closure Studs (B2.3)	XI.M03	Seung Min	Roger Kalikian, Matt Homiack	Omesh Chopra	Blew, Michael
Boric Acid Corrosion (B3.2)	XI.M10	John Burke	John Wise	Omesh Chopra	Pizzuti
Nickel-alloy Nozzles and Penetrations (B4.1)	XI.M11B	Amy Hull	Roger Kalikian, Matt Homiack	Omesh Chopra	Blew, Michael
Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)(B4.2)	XI.M12	Seung Min	Roger Kalikian, Matt Homiack	Omesh Chopra	Blew, Michael
PWR Vessel Internals (B4.3)	XI.M16A	Allen Hiser	Jim Medoff, Ganesh Cheruvenki	Omesh Chopra	Martrano
Flow-Accelerated Corrosion (B3.3)	XI.M17	Jim Gavula	Aloysius Obodoaka	Yogen Garud	McCutcheon

Robinson AMP (see NUREG-1785, & Robinson LRA Appendix B)	GALL	NRC staff on audit	NRC staff at headquarters	Argonne Support	RNP POC
Bolting Integrity (B3.4)	XI.M18	Jim Gavula	John Wise	Yogen Garud	Flowers
Steam Generator Tube Integrity (B2.4)	XI.M19	Seung Min	Aloysius Obodoaka	Yogen Garud	Hendrickson
Open-Cycle Cooling Water System (B3.5)	XI.M20	Jim Gavula		Dwight Diercks	Ludwick
2Closed-Cycle (Component) Cooling Water System (B2.5)	XI.M21A	Jim Gavula	John Wise	Dwight Diercks	Ludwick
Inspection of Heavy & Light Load (Related to Refueling) Handling Systems (B3.6)	XI.M23	Bennett Brady	John Wise	Dave Ma	Erno
Fire Protection (B3.1)	XI.M26	Amy Hull	Albert Wong	Dave Ma	Thompson & Wallace
Fire Water System (B3.7)	XI.M27	Amy Hull	Albert Wong	Dave Ma	Thompson & Wallace
Aboveground Carbon Steel Tanks (B3.9)	XI.M29	Bryce Lehman	Abdul Sheikh	Dave Ma	Crabtree
Fuel Oil Chemistry (B3.10)	XI.M30	Allen Hiser	Aloysius Obodoaka	Dwight Diercks	Snipes
Reactor Vessel Surveillance (B3.11)	XI.M31	Allen Hiser	Jim Medoff, Jeff Poehler, Pat Purtscher	Yogen Garud	Martrano
One-Time Inspection (B4.4)	XI.M32	Jim Gavula	Glenn Meyer	Dwight Diercks	Bardauskas, Tom
Selective Leaching of Materials (B4.5)	XI.M33	Bennett Brady	John Wise, Glen Meyer	Dwight Diercks	Bardauskas, Tom
Flux Thimble Eddy Current Inspection (B2.8)	XI.M37	Amy Hull	Roger Kalikian, Matt Homiack	Yogen Garud	Balakhnin
Buried Piping and Tanks Inspection (B3.12) & Surveillance (B3.8) - two different audit worksheets prepared	XI.M41	Allen Hiser & John Burke	Glenn Meyer, Bill Holston	Dwight Diercks	McCutcheon
ASME Sect XI, Subsections IWE Inservice Inspection (B3.13)	XI.S1	Bryce Lehman	Abdul Sheikh	Dave Ma	Blew, Michael
ASME Sect XI, Subsections IWL Inservice Inspection (B3.14)	XI.S2	Bryce Lehman	Abdul Sheikh	Dave Ma	Blew, Michael
ASME Section XI, Subsection IWF, Inservice Inspection (B2.6)	XI.S3	Bryce Lehman	Abdul Sheikh	Dave Ma	Blew, Michael
10 CFR Part 50, Appendix J (B2.7) (containment leak rate tests)	XI.S4	Bryce Lehman		Dave Ma	McCutcheon
Structures Monitoring (B3.15)	XI.S5, XI.S7	John Burke	Abdul Sheikh	Dave Ma	Erno

NA — Information not available.