CALLAWAY PLANT UNIT 1
LICENSE RENEWAL APPLICATION

REQUEST FOR ADDITIONAL INFORMATION (RAI) SET #28 RESPONSES

RAI 3.0.3-1

Background:

Recent industry operating experience (OE) and questions raised during the staff's review of several License Renewal Applications (LRAs) has resulted in the staff concluding that several Aging Management Programs (AMP) and Aging Management Review (AMR) items in the LRA may not or do not account for this OE.

Issue: Recurring internal corrosion

When the staff reviewed recent LRAs and industry OE, it was evident that some plants have experienced repeated instances of internal aging in piping systems that should result in the aging effect to be considered recurring. In each of these instances, the applicant had to augment LRA AMPs and AMR items to fully address the aging effect during the period of extended operation (PEO). To date, examples of these aging effects have included microbiologically-influenced corrosion (MIC).

Potential augmented aging management activities include: alternative examination methods (e.g., volumetric versus external visual), augmented inspections (e.g., a greater number of locations, additional locations based on risk insights based on susceptibility to aging effect and consequences of failure, a greater frequency of inspections), and additional trending parameters and decision points where increased inspections would be implemented.

Recurring internal corrosion is identified by both the number of occurrences of internal aging effects with similar aging mechanisms and the extent of degradation at each localized site. The term "recurring internal corrosion" is not intended to address aging effects that occur infrequently or occurred frequently in the past but have been subsequently corrected. An aging effect should be considered recurring from a frequency perspective if the search of 10 years of plant-specific OE reveals repetitive occurrences (e.g., one per refueling outage cycle that has occurred over 3 or more sequential or non-sequential cycles) of aging effects with the same aging mechanism.

The staff recognizes that not all aging effects are significant enough to warrant augmented aging management activities. As a plant ages there can be numerous examples of inconsequential aging effects. This RAI is focused on recurring internal corrosion in which the component's degree of degradation is significant such that it either does not meet plant-specific acceptance criteria (e.g., component had to be repaired or replaced), or the degradation exceeded wall penetration greater than 50 percent, regardless of the minimum wall thickness.

The staff also recognizes that in many instances a component would be capable of performing its intended function even if the degradation met this threshold. The staff does not intend that the 50 percent through-wall penetration or greater criterion be interpreted to indicate that the in-scope component does or did not meet its intended function, but rather as an indicator of aging effects significant enough to warrant enhanced aging management actions. For example, localized 50 percent deep pits in typical service water systems typically do not challenge the pressure boundary function of a component.

Based on the industry OE, components in the Engineered Safety Features Systems (LRA Section 3.2), Auxiliary Systems (LRA Section 3.3), and Steam and Power Conversion Systems (LRA Section 3.4) should be addressed.

The staff noted that Safety Evaluation Report (SER) Section 3.0.3.2.3 addresses MIC on the internal surfaces of essential service water system piping. However, it is not clear to the staff how the aging effects for the remaining in-scope carbon steel piping will be managed in light of the recurring internal corrosion that occurred in this system.

The staff noted that SER Section 3.0.3.2.7 addresses how MIC on the internal surfaces of fire water system piping will be age-managed during the period of extended operation. The staff's review of these changes to the LRA confirmed that the proposed approach is consistent with this RAI.

Request:

Based on the results of a review of the past 10 years of plant-specific OE, if recurring internal corrosion has occurred in raw water or waste water environments, provide the following (MIC on the internal surfaces of fire water system piping need not be addressed in the response to this RAI):

a. Describe each aging effect and its extent.

b. State why the applicable programs' examination methods will be sufficient to detect the recurring aging mechanism before affecting the ability of a component to perform its intended function.

c. The basis for the adequacy of augmented or lack of augmented inspections.

d. What parameters will be trended as well as the decision points where increased inspections would be implemented (e.g., extent of degradation at individual corrosion sites, rate of degradation change).

e. The basis for parameter testing frequency and how it will be conducted.

f. How inspections of not easily accessed components (i.e., buried, underground) will be conducted.

g. If buried components are involved, how leaks will be identified.

h. The program(s) that will be augmented to include the above requirements.

Callaway Response

a. The past ten years of plant-specific operating experience were reviewed to identify if recurring internal corrosion had occurred in raw water or waste water environments. SER Section 3.0.3.2.7 addresses how microbiologically-influenced corrosion (MIC) on the internal surfaces of the fire water system piping will be age-managed and was not addressed in this review.

Aging is identified as recurring internal corrosion by both the number of occurrences (frequency) of internal aging effects with similar aging mechanisms and the extent of degradation (significance) at each localized site. The term recurring internal corrosion is not intended to address aging effects that occur infrequently or occur frequently in the past but have been subsequently corrected (e.g. component was repaired or replaced). An aging effect is considered as recurring internal corrosion if it has occurred over three or more sequential or non-sequential cycles for a 10-year OE search of aging effects with the same aging mechanism and for which the aging effect resulted in the component not meeting plant-specific acceptance criteria or experiencing a reduction in wall thickness greater than 50 percent regardless of the minimum wall thickness.

Callaway has identified MIC as recurring internal corrosion (RIC) for the essential service water (ESW) system. With exception of the fire water system piping, there is no aging degradation associated with components in other raw water or waste water environment within the scope of license renewal that meet the frequency and significance criteria for recurring internal corrosion.

When recurring internal corrosion due to MIC was identified on carbon steel essential service water components, the components were repaired, replaced or subsequently scheduled for replacement. As result of a system wide inspection project in 2007/2008 and high-density polyethylene (HDPE) pipe replacements from 2008 to 2009; there have only been two occurrences of ESW carbon steel piping inspection results since 2009 that did not meet minimum wall criteria and were not replaced with stainless steel or HDPE materials. One occurrence was replaced with carbon steel and the other one is being monitored and trended. Also since 2009 there was no through wall leakage identified on ESW piping that was not repaired or replaced with stainless steel or HDPE materials. During 2003 to 2008, there were three occurrences of ESW carbon steel piping leakage or inspection results that did not meet minimum wall criteria and were not replaced with stainless steel or HDPE materials. All three occurrences were weld repaired or replaced with carbon steel material.

In 2007/2008, Callaway conducted a three phase project to inspect above-ground carbon steel ESW piping. The first phase started in Fall 2007 in which approximately 220 feet of high risk lines was inspected using low-frequency electromagnetic testing (LFET). The second phase of the inspections occurred in the Spring of 2008 and covered approximately 2000 feet of ESW piping. Due to the satisfactory conditions identified during phase 1 and 2 inspections, the scope for phase 3 (Fall 2008) was reduced to roughly 300 feet. Since the completion of this project, ESW piping continues to be inspected each refueling outage. In the last three refueling outages, approximately 800 feet of piping was inspected with LFET.

Callaway has replaced a substantial amount of ESW piping. Over a period of several years starting in the mid-1990s nearly 3400 feet of small bore (four inch and smaller) carbon steel pipe was replaced with 316L stainless steel pipe. From 2008 to 2009, the buried portions of the ESW supply from the ESW pump house and return to the ultimate heat sink cooling tower were replaced with high-density polyethylene (HDPE) piping. During Refuel 15 (Spring, 2007), an extensive inspection campaign resulted in the replacement of 79 feet of 30-inch piping, several sections of 8-inch and 6-inch piping, the pump discharge spool and reducer for both the 'A' and 'B' trains, and the pump discharge cross-connect spool piece.

b. As stated in response (a.), MIC has been identified as recurring internal corrosion (RIC) in Essential Service Water (ESW) piping. For the selected sections of ESW piping that are inspected each outage for corrosion, erosion and biofouling, the criteria used to select the locations include: operating condition (areas with stagnant/intermittent flow), pipe material, piping age, pipe configuration, results of previous inspections, recent/near term challenges with the system/piping, chemistry trend data (MIC sampling), industry operating experience and system engineering recommendations. The number of selected locations varies from outage to outage based on the previously mentioned sample criteria. The inspection methods include Ultrasonic Thickness (UT), Low Frequency Electromagnetic Technique (LFET) and opportunistic visual inspections. LFET is a form of electromagnetic testing and is used specifically for screening large areas of piping quickly. The LFET scanner is moved across the pipe and will detect changes in the wall thickness of the pipe as it moves across the surface. Thinned areas found during the LFET scan are followed up with UT measurements to determine pipe wall thickness measurements.

A plant procedure provides acceptance criteria for minimum wall thickness for general area inspections and for localized defects. Engineering evaluations may be used to accept a wall thickness which is less than that provided by the procedure. Components are repaired, replaced, or monitored, if necessary, based on the rate of corrosion and the results of the minimum wall thickness evaluations and/or corrective action program recommendations.

c. As result of a system wide inspection project in 2007/2008 and HDPE pipe replacements from 2008 to 2009; there have only been 2 occurrences of ESW carbon steel piping inspection results since 2009 that did not meet minimum wall results and were not repaired or replaced with stainless steel or HDPE materials. Also since 2009 there was no through wall leakage identified on ESW piping that was not repaired or replaced with stainless steel or HDPE materials. The number of inspections and the interval between inspections are determined based on inspection results. Since 2009, the fact that neither pipe leaks nor pipe wall thinning has resulted in the loss of component ability to support system pressure and flow requirements indicate that augmented inspections are not necessary at this time and the existing approach is adequate.

d. See the response in part b. Wall thickness is the parameter monitored to evaluate RIC due to MIC. Wall thickness measurements are taken at multiple locations based on LFET results that indicate the potential for wall thinning. The responsible engineer determines if a UT location requires future trending and the installation of permanent grids. Since refueling outage 15 in 2007, LFET inspections have been performed each refueling outage. Locations that require trending are also examined each refueling outage or at an interval specified in the corrective action evaluation based on the expected time to prevent a thinned location from reaching the minimum wall thickness.

e. See the response in part d.

f. The ESW system includes sections of buried carbon steel piping that are not easily accessible for inspection. Prior to the period of extended operation, an inspection technique will be selected from available technologies to identify internal pipe wall degradation due to MIC for a buried carbon steel ESW piping segment that is representative of other accessible carbon steel ESW piping segments.

g. Although underground leaks are possible, leaks large enough to affect the pressure and flow functions of the ESW system are expected to develop slowly. Such leaks are detectable by changes in system performance, changes in system operation, or by the appearance of wetted ground around the leak. Prior to the period of extended operation a one-time inspection of a buried carbon steel ESW piping segment will be performed to confirm that inspection results of accessible ESW carbon steel components are providing similar results.

h. The Open Cycle Cooling Water System will be enhanced to perform the following inspection:

    Prior to the period of extended operation, an inspection technique will be selected from available technologies to identify internal pipe wall degradation due to MIC for performance of a one-time inspection of a buried carbon steel ESW piping segment that is representative of other accessible carbon steel ESW piping segments.

LRA Appendix A1.10, LRA Table A4-1 item 6, and LRA Appendix B2.1.10 have been revised as shown in Amendment 28 in Enclosure 2 to inspect a buried carbon steel ESW piping segment for MIC degradation prior to the period of extended operation. In addition, aging evaluations for recurring internal corrosion have been added to LRA Table 3.3.2-4 for the Essential Service

Water System. LRA Table 3.3-1 has been revised and LRA Further Evaluation 3.3.2.2.8 has been added consistent with this evaluation of RIC on the ESW system.

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table “Amendment 28, LRA Changes for LRA Annual Update and RAI Set 28” for a description of LRA changes with this response.

RAI 3.0.3-2

Background:

Recent industry OE and questions raised during the staff's review of several LRAs has resulted in the staff concluding that several AMPs and AMR items in the LRA may not or do not account for this OE.

Issue: Loss of coating integrity for Service Level Ill and Other coatings

Industry OE indicates that degraded coatings have resulted in unanticipated or accelerated corrosion of the base metal and degraded performance of downstream equipment (e.g., reduction in flow, drop in pressure, reduction in heat transfer) due to flow blockage. Based on these industry OE examples, the staff has questions related to how the aging effect, loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage, would be managed for Service Level III and Other coatings.

For purposes of this RAI:

a. Service Level III coatings are those installed on the interior of in-scope piping, heat exchanges, and tanks which support functions identified under 10 CFR 54.4(a)(1) and (a)(2).
b. "Other coatings," include coatings installed on the interior of in-scope piping, heat exchangers, and tanks whose failure could prevent satisfactory accomplishment of any of the functions identified under 10 CFR 54.4(a)(3).
c. The term "coating" includes inorganic (e.g., zinc-based) or organic (e.g., elastomeric or polymeric) coatings, linings (e.g., rubber, cementitious), and concrete surfacers that are designed to adhere to a component to protect its surface.
d. The terms "paint" and "linings" should be considered as coatings.

The staff believes that to effectively manage loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage of Service Level Ill and Other coatings an AMP should include:

a. Baseline visual inspections of coatings installed on the interior surfaces of in-scope components should be conducted in the 10-year period prior to the PEO.
b. Subsequent periodic inspections where the interval is based on the baseline inspection results. For example:
    i. If no peeling, delamination, blisters, or rusting are observed, and any cracking and flaking has been found acceptable, subsequent inspections could be conducted after multiple refueling outage intervals (e.g., for example six years, or more if the same coatings are in redundant trains).
    ii. If the inspection results do not meet the above; but, a coating specialist has determined that no remediation is required, subsequent inspections could be conducted every other refueling outage interval.
    iii. If coating degradation is observed that required repair or replacement, or for newly installed coatings, subsequent inspections should occur over the next two refueling outage intervals to establish a performance trend on the coatings.

c. All accessible internal surfaces for tanks and heat exchangers should be inspected. A representative sample of internally coated piping components should be inspected based on a 95-percent confidence level.

d. Coatings specialists and inspectors should be qualified in accordance with an American Society for Testing and Materials (ASTM) International standard endorsed in Regulatory Guide (RG) 1.54, "Service Level I, II, and III Protective Coatings Applied to Nuclear Power Plants," including staff guidance associated with a particular standard.

e. Monitoring and trending should include pre-inspection reviews of previous inspection results.

f. The acceptance criteria should include that indications of peeling and delamination are not acceptable. Blistering can be evaluated by a coating specialist; however, physical testing should be conducted to ensure that the blister is completely surrounded by sound coating bonded to the surface.

   The staff noted that essential service water internal coatings were addressed in SER Section 3.0.3.2.3. The staff's evaluation of the proposed approach noted two areas where further information is required for these coatings. These include the inspection interval for newly installed or repaired coatings and the extent of inspections (e.g., number of inspection points or surface area to be inspected).

Request:

If coatings have been installed on the internal surfaces of in-scope components (i.e., piping, piping subcomponents, heat exchangers, and tanks), state how loss of coating integrity due to blistering, cracking, flaking, peeling, or physical damage will be managed, including:

a. the inspection method
b. the parameters to be inspected
c. when inspections will commence and the frequency of subsequent inspections
d. the extent of inspections and the basis for the extent of inspections if it is not 100 percent
e. the training and qualification of individuals involved in coating inspections
f. how trending of coating degradation will be conducted
g. acceptance criteria
h. corrective actions for coatings that do not meet acceptance criteria, and
i. the program(s) that will be augmented to include the above requirements.

If necessary, provide revisions to LRA Section 3 Table 2s, Appendix A, and Appendix B.

Callaway Response

a. Visual inspection of the coatings installed on the interior surface of in-scope components for deterioration or degradation evidenced by blistering, cracking, peeling, or delamination is performed.

b. The monitored parameter is the integrity of the coating installed on the interior surface of in-scope components.

c. Baseline visual inspections of coatings installed on the interior surface of in-scope components will be conducted in the ten-year period prior to the period of extended operation. Subsequent periodic inspections will be performed as follows based on the initial inspection results.

   i. If no peeling, delamination, blisters, or rusting are observed, and any cracking or flaking has been found to be acceptable based on an evaluation by the coating specialist, subsequent inspections will be performed at least once every six years. If no indications are found during inspection of one train, the redundant train would not be inspected.

   ii. If the inspection results do not meet item "c.i" above: but, a coating specialist has determined that no remediation is required, the subsequent inspections will be conducted every other refueling outage.

   iii. If coating degradation is observed that required repair or replacement, or newly installed coatings, subsequent inspections will occur during each of the next two refueling outages to establish a performance trend on the coating.

d. The only tanks within the scope of license renewal that have interior coated surfaces are the fire water storage tanks (FWSTs) and the Fuel Oil Storage Tanks (FOSTs). The interior surfaces of the FWSTs are managed by the Fire Water Systems program (B2.1.14). The interior surfaces of the FOSTs are managed by the Fuel Oil Chemistry program (B2.1.16). There is no piping within the scope of license renewal that has interior coated surfaces. One hundred percent (100%) of the accessible interior surfaces of the following components will be managed by the Open Cycle Cooling Water System program (B2.1.10):

   - Component Cooling Water Heat Exchangers
   - Electrical Equipment Air Conditioners
   - Control Room Air Conditioners
   - Essential Service Water Self-Cleaning Strainers

   In addition, 100% of the accessible interior surfaces of the service water pump strainers will be managed by the Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program (B2.1.23).

e. Coating inspections will be performed by individuals qualified certified to ANSI N45.2.6, “Qualification of Inspections, Examinations, and Testing Personnel for Nuclear Power Plants”. Inspection reports will be provided to the site coatings coordinator for evaluation. The site coatings coordinator will be qualified consistent with ASTM D7108-05, “Standard Guide for Establishing Qualifications for a Nuclear Coating Specialist,” as described in the Protective Coating Monitoring and Maintenance program (B2.1.33).

f. Monitoring and trending will include pre-inspection reviews of previous inspection results. Inspection results will be compared to previous inspection results.

g. The following acceptance criteria will be used:

   - Peeling and delaminations are not permitted.
   - Cracking is not permitted if accompanied by delamination or loss of adhesion.

- Blisters are limited to intact blisters. Testing will be performed to confirm that the blisters are completely surrounded by sound coating bonded to the surface.
- Localized areas of coating degradation without subsequent loss of material of the base metal are considered acceptable if the area is completely surrounded by sound coating bonded to the surface.

h. Inspections not meeting the acceptance criteria will be evaluated by the site coatings coordinator. Corrective actions will be determined using the Callaway corrective action program and may include repair, replacement, or continued monitoring.

i. The staff noted that essential service water internal coatings were addressed in SER section 3.0.3.2.3. The Open Cycle Cooling Water System program (B2.1.10) and the Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program (B2.1.23) will be augmented to address the aging management requirements noted above.

LRA Appendix A1.10, Appendix A1.23, Table A4-1 Item 6, Appendix B2.1.10, and Appendix B2.1.23 have been revised as shown in Amendment 28 in Enclosure 2 to inspect the coating installed on the interior surface of in-scope components using the Open Cycle Cooling Water System program (B2.1.10) and the Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components program (B2.1.23). In addition aging evaluation of coatings installed on the interior surface of in-scope components has been revised for the following systems as noted in LRA Chapter 3.

- Table 3.3.2-4, Essential Service Water System.
- Table 3.3.2-5, Service Water System
- Table 3.3.2-7, Component Cooling Water System
- Table 3.3.2-11, Control Building HVAC System.
- Table 3.3.2-20, Fire Protection System
- Table 3.3.2-21, Emergency Diesel Engine Fuel Oil Storage and Transfer System

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table “Amendment 28, LRA Changes for LRA Annual Update and RAI Set 28” for a description of LRA changes with this response.

RAI 3.0.3-3

Background:

Recent industry OE and questions raised during the staff's review of several LRAs has resulted in the staff concluding that several AMPs and AMR items in the LRA may not or do not account for this OE.

Issue:

Managing aging effects of fire water system components

Industry OE has indicated that flow blockages have occurred in dry sprinkler piping that would have resulted in failure of the sprinklers to deliver the required flow to combat a fire. This OE is described in NRC Information Notice (IN) 2013-06, "Corrosion in Fire Protection Piping Due to Air and Water Interaction." The common cause is air and water interactions leading to accelerated corrosion that occurred in normally dry fire water piping that had been subject to inadvertent flow or flow tested, and which may not have been properly drained. As stated in IN 2013-06, had inspections been conducted by the National Fire Protection Association (NFPA) 25 2011 Edition, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," the obstructions may have been detected. As such, in regards to the recommendations in GALL Report AMP XI.M27, "Fire Water System," and GALL Report AMP XI.M29 "Aboveground Metallic Tanks", the staff believes that:

a. The tests and inspections listed in Table 1, "Fire Water System Inspection and Testing Recommendations," of this RAI should be conducted.

b. Wall thickness evaluations used as an alternative instead of flow tests or internal visual examinations for managing flow blockage should not be credited for aging management because external wall thickness measurements may not be capable of identifying when sufficient general corrosion has occurred such that the corrosion products cause flow blockage. The first enhancement associated with the "parameters monitored or inspected," and "detection of aging effects" program element of the Fire Water System Program states that:

> The Fire Water System program will be enhanced to include pipe wall thickness examinations on fire water piping. As an alternative to wall thickness examinations, internal inspections will be performed on accessible exposed portions of fire water piping during plant maintenance activities. Pipe wall thickness examinations and/or internal inspections will be performed prior to the period of extended operation and at 10-year frequencies throughout the period of extended operation.

   It is not clear to the staff whether the pipe wall thickness examinations could be conducted exclusively in lieu of internal inspections.

c. If internal visual inspections detect surface irregularities because of corrosion, follow-up volumetric examinations should be performed. These follow-up exams ensure that there is sufficient wall thickness in the vicinity of the irregularity.

d. For portions of water-based fire protection system components that are periodically subjected to flow but designed to be normally dry, such as dry-pipe or preaction sprinkler system piping and valves, augmented inspections should be performed in the portions of this piping that are not configured to completely drain. The augmented inspections should consist of internal visual examination or full flow testing of the entire portion that is not configured to completely drain. Given the potential for accelerated corrosion in the portions of this piping that are not configured to completely drain, periodic wall thickness measurements should be conducted.

e. Fire water storage tanks should be inspected to the requirements of NFPA 25. The inspection requirements in NFPA 25 Chapter 9, "Water Storage Tanks," are different than the recommendations in GALL Report AMP XI.M29. For example, NFPA 25 states that external inspections are conducted quarterly and interior inspections are conducted on a 3-year interval if the tank does not have internal corrosion protection; otherwise, the inspections are conducted on a 5-year interval. In contrast, GALL Report AMP XI.M29 recommends that external inspections occur on a refueling outage interval and internal inspections are conducted every 10 years.

Request:

a. If inspections of the fire water system components will not be conducted consistent with the guidance in Table 1, provide justification for the currently planned actions previously described in the LRA.

b. If follow-up volumetric examinations will not be conducted when internal visual inspections detect surface irregularities that could be indicative of wall loss below nominal pipe wall thickness, state the basis for why visual inspections alone will provide reasonable assurance that the intended functions of in-scope fire water system components will be maintained consistent with the current licensing basis (CLB) for the PEO. Alternatively, add a requirement to the program to conduct follow-up volumetric examinations.

c. State whether wall thickness evaluations will be used in lieu of conducting flow tests or internal visual examinations, and if it is, state the basis for why wall thickness measurements in the absence of flow testing or internal visual examinations provide reasonable assurance that the intended functions of in-scope fire water system components will be maintained consistent with the CLB for the PEO.

d. For portions of water-based fire protection system components that are periodically subjected to flow but designed to be normally dry, such as dry-pipe or preaction sprinkler system piping and valves, but not configured to completely drain, state the following:

   i. the inspection method to ensure that fouling is not occurring

   ii. the parameters to be inspected

   iii. when inspections will commence and the frequency of subsequent inspections

   iv. the extent of inspections and the basis for the extent of inspections if it is not 100 percent

   v. acceptance criteria, and

   vi. how much of this piping will be periodically inspected for wall thickness and how often the inspections will occur.

e. State why conducting inspections consistent with the current provisions in the LRA provides reasonable assurance that the intended functions of fire water storage tank will be maintained consistent with the CLB for the PEO. Alternatively, revise the Fire Water System Program to conduct tank inspections consistent with the inspections recommendations of Table 1.

If necessary, provide revisions to LRA Section 3 Table 2s, Appendix A, and Appendix B.

Callaway Response

a. The Fire Water System program will require the following tests and inspections identified in Table 1 of RAI 3.0.3-3.

Component – Sprinkler Systems: Sprinkler inspections
NFPA 25 Section – 5.2.1.1
Aging Management Performed - Sprinklers are inspected for signs of leakage, corrosion, and foreign material.

Component – Sprinkler Systems: Sprinkler testing
NFPA 25 Section – 5.3.1
Aging Management Performed - Prior to 50 years in service, the Fire Water System program requires sprinkler heads to be replaced or have representative samples submitted for field-service testing by a recognized testing laboratory in accordance with NFPA 25. The program field-service tests additional representative samples every 10 years thereafter during the period of extended operation to ensure signs of aging are detected in a timely manner.

Component – Standpipe and Hose Systems: Flow Tests
NFPA 25 Section – 6.3.1
Aging Management Performed - Flow testing is conducted at least every five years at the hydraulically most remote hose connections of each zone of an automatic standpipe system to verify the water supply provides the design pressure at the required flow.

Component – Private Fire Service Mains: Underground and Exposed Piping
NFPA 25 Section – 7.3.1
Aging Management Performed - Underground and exposed piping is flow tested at flows representative of those during a fire to determine the internal condition of the piping at minimum 3-year intervals.

Component – Private Fire Service Mains: Hydrants
NFPA 25 Section – 7.3.2
Aging Management Performed - Hydrants are flow tested annually to ensure proper functioning.

Component – Fire Pumps: Suction Screens
NFPA 25 Section – 8.3.3.7
Aging Management Performed – Not applicable. Callaway's fire protection pumps do not have suction screens.

Component – Water Storage Tanks: Exterior inspections
NFPA 25 Section – 9.2.5.5
Aging Management Performed - The exterior painted surface of the fire water storage tanks (FWSTs) is inspected annually for signs of degradation.

Component – Water Storage Tanks: Interior inspections
NFPA 25 Section – 9.2.6, 9.2.7
Aging Management Performed - The interior of each FWST is inspected every other refueling cycle for signs of aging. Testing of interior surfaces is performed for coating integrity and tank bottom integrity when FWSTs exhibit signs of interior pitting, corrosion, or coating failure.

Component – Valves and System-Wide Testing: Main Drain Test
NFPA 25 Section – 13.2.5
Aging Management Performed - Main drain tests are not conducted at Callaway. Main drain testing is a potentially risk significant activity due to the potential for water contacting critical

equipment in the area. In addition, main drain testing requires the discharge of several thousand gallons of water in radiological areas, the disposal of which may be problematic for a nuclear plant. As an alternative, one of the following methods is used to assure the reliable operation of the fire protection water supply system.

1. The fire suppression system is fed from two or more directions such that the failure of one isolation valve will not impair the system and the long runs of pipe are flow tested under other surveillances.

   OR

2. The flow path from the fire pump to the system control valve is verified on an 18-month frequency, and the following surveillances are performed with acceptable results:

   - Fire water valve position verification
   - Fire protection valve cycling
   - Annual fire protection loop flow test
   - Fire protection water system flush
   - Hydrant flush
   - Post indicator valve testing
   - Wet pipe, deluge, and Preaction system visual inspection

Component – Valves and System-Wide Testing: Deluge Valves
NFPA 25 Section – 13.4.3.2.2 to 13.4.3.2.5
Aging Management Performed - A full flow test using air or water is performed every refueling outage by trip testing each deluge valve to verify that spray/sprinkler nozzles are unobstructed.

Component – Water Spray Fixed Systems: Strainers
NFPA 25 Section – 10.2.1.6, 10.2.1.7, 10.2.7
Aging Management Performed - Spray system strainers are inspected and cleaned every refueling outage and after each system actuation. Callaway does not have main line strainers.

Component – Water Spray Fixed Systems: Operation Test
NFPA 25 Section – 10.3.4.3
Aging Management Performed - A full flow test is performed every refueling cycle using air or water to verify that spray/sprinkler nozzles are unobstructed.

Component – Foam Water Sprinkler Systems: Strainers
NFPA 25 Section - 11.2.7.1
Aging Management Performed – Not applicable. Callaway does not have a foam water sprinkler system.

Component – Foam Water Sprinkler Systems: Operational Test Discharge Patterns
NFPA 25 Section - 11.3.2.6
Aging Management Performed - Not applicable. Callaway does not have a foam water sprinkler system.

Component – Foam Water Sprinkler Systems: Storage tanks
NFPA 25 Section – Visual Inspection for internal corrosion
Aging Management Performed - Not applicable. Callaway does not have a foam water sprinkler system.

Component – Obstruction Investigation: Obstruction, Internal Inspection of Piping
NFPA 25 Section – 14.2 and 14.3
Aging Management Performed - The internal surface of piping and branch lines is inspected for foreign material every five years by flushing wet pipe system piping. In buildings having multiple wet pipe systems, every other system is inspected every five years, and the remaining systems are inspected at the next five year interval. If foreign material is found in any system in a building during the five year inspection, then all systems in the building will be inspected.

If sufficient foreign material is found to obstruct pipe or sprinklers, then an obstruction investigation is conducted. If the visual inspection detects surface irregularities that could indicate wall loss below nominal pipe wall thickness, then follow-up volumetric examinations will be performed.

LRA Table 3.3-1, Table 3.3.2-20, LRA Appendix A1.14, LRA Table A4-1 item 10, and LRA Appendix B2.1.14 have been revised as shown in Amendment 28 in Enclosure 2 to include aging management of the Fire Water System program consistent with the NFPA-25 tests and inspections in AMP XI.M27 Table 4a of LR-ISG-2012-02. Note that Ameren Missouri submitted a license amendment request (see ULNRC-05781 dated August 29, 2011) for Callaway Plant Unit 1 to adopt National Fire Protection Association Standard 805 (NFPA 805). As part of transitioning of the Callaway fire protection licensing basis to a performance based program under NFPA 805, test and inspection commitments will be reviewed and may be revised consistent with the revised licensing basis.

b. Internal visual inspections are performed during plant maintenance activities and the five year flush of wet pipe system piping. When internal visual inspections are used to detect loss of material, the inspection technique will be capable of detecting surface irregularities that could indicate wall loss to below nominal pipe wall thickness due to corrosion and corrosion product deposition. Where such irregularities are detected, follow-up volumetric wall thickness examinations will be performed.

Applicable enhancements in LRA Table A4-1 item 10 and in Appendix B2.1.14 have been revised as shown in Amendment 28 in Enclosure 2 to require volumetric examinations when internal visual inspections detect surface irregularities that could be indicative of wall loss below nominal pipe wall thickness.

c. Wall thickness examinations are not used in lieu of conducting flow tests or internal visual examinations. Wall thickness examinations will be performed on fire water piping every three years. As noted in the RAI part b response, follow-up volumetric wall thickness examinations are performed in conjunction with visual inspections when surface irregularities are detected. As noted in the RAI part d response, volumetric wall thickness examinations will be performed in addition to the flow testing or visual inspections of fire water system piping that are periodically subject to flow, but designed to be normally dry and cannot be drained or allow water to collect.

d. The portions of the fire water system that are periodically subject to flow, but designed to be normally dry, such as dry-pipe or preaction sprinkler system piping and valves, will be identified and inspected prior to the PEO. For those piping segments where drainage may not occur as expected, the following actions will be performed.

   i. Either a flow test or flush sufficient to detect potential flow blockage, or a visual inspection of 100% of the internal surface of the piping segments that cannot be drained or allow water to collect will be conducted.

ii. The piping segment where drainage is not occurring as expected will be monitored for flow blockage or loss of material.

iii. Inspections will be performed in each five-year interval beginning five years prior to the PEO. A 100% baseline inspection will be performed prior to the period of extended operation with 20% of the inspections performed in each five year interval of the period of extended operation.

iv. See the response in part "i" for the extent of the inspections.

v. Inspections will be acceptable if there is no debris that could obstruct pipe or sprinklers and minimum design wall thickness is maintained.

vi. In each five year interval of the PEO, 20% of the length of piping segments that cannot be drained or that allow water to collect will be subject to volumetric wall thickness examinations. The 20% of piping that is periodically inspected in each five-year interval will be in different locations than previously inspected piping. If the results of a 100% internal visual inspection are acceptable, and the segment is not subsequently wetted, no further augmented tests or inspections will be performed.

LRA Table A4-1 item 10 and LRA Appendix B2.1.14 have been revised as shown in Amendment 28 in Enclosure 2 to include the tests and inspections noted in this response for those normally dry piping segments subjected to periodic flow where drainage is not occurring as expected in the Fire Water System program.

e. The fire water storage tanks have been removed from the Aboveground Metallic Tanks program (B2.1.15) and included in the Fire Water Systems program (B2.1.14).

LRA Table 3.3-1, Table 3.3.2-20, LRA Appendix A1.14, LRA Appendix A1.15, LRA Table A4-1 item 10, LRA Appendix B2.1.14, and LRA Appendix B2.1.15 have been revised as shown in Amendment 28 in Enclosure 2 to inspect the fire water storage tanks internal and external surfaces consistent with the 2011 Edition of NFPA 25 under the Fire Water System program.

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table "Amendment 28, LRA Changes for LRA Annual Update and RAI Set 28" for a description of LRA changes with this response.

RAI 3.0.3-4

Background:

Recent industry OE and questions raised during the staff's review of several LRAs has resulted in the staff concluding that several AMPs and AMR items in the LRA may not or do not account for this OE.

Issue: Scope and inspection recommendations of GALL Report AMP XI.M29, "Aboveground Metallic Tanks"

There have been several instances of OE related to age-related degradation of tanks. Tanks with defects variously described as wall thinning, pinhole leaks, cracks, and through-wall flaws have been identified by detecting external leakage rather than through internal inspections. None of the leaks has resulted in a loss of intended function; however, the number of identified instances of tank degradation and the continued aging of the tanks indicate a need for internal tank inspections to be conducted throughout the PEO. In addition, the staff identified two indoor tanks with external stress-corrosion cracking (SCC) that, except for their location, would normally be in the scope of GALL Report AMP XI.M29. As such, in regard to the recommendations in GALL Report XI.M29, the staff believes that:

a. Certain indoor tanks should be within the scope of GALL Report AMP XI.M29. These include indoor welded storage tanks that meet all of the following criteria:
    I. have a large volume (i.e., greater than 100,000 gallons)
    II. are designed to near-atmospheric internal pressures
    III. sit on concrete
    IV. are exposed internally to water
b. Based on industry OE related to cracking due to SCC, stainless steel and aluminum tanks should be inspected using surface examination techniques.
c. Based on the tank's material and environment, the attached Table 2, "Tank Inspection Recommendations," contains the types of aging effects requiring management (AERM), inspection type, and frequency of inspections that should be conducted to provide reasonable assurance that the intended functions of the tank will be maintained consistent with the CLB for the PEO.

Request:

a. If there are any in-scope indoor welded storage tanks that meet all of the criteria for inclusion within the scope of GALL Report AMP XI.M29, state why conducting inspections consistent with the current provisions in the LRA provides reasonable assurance that the tank(s)' intended functions will be maintained consistent with the CLB for the PEO. Alternatively, revise the program to conduct tank inspections consistent with Table 2.
b. If necessary, provide revisions to LRA Section 3 Table 2s, Appendix A, and Appendix B.

Callaway Response

a. There are no in-scope indoor welded storage tanks that meet all of the following criteria for inclusion within the scope of GALL Report AMP XI.M29:

- have a large volume (i.e., greater than 100,000 gallons)
- are designed to near-atmospheric internal pressures
- sit on concrete
- are exposed internally to water

b. The Fire Water System program (B2.1.14) has been revised to include the aging management recommendations for the fire water storage tanks (FWSTs) noted on Table 1 of RAI 3.0.3-3. Aging management of the fire water storage tanks has been deleted from the scope of the Aboveground Metallic Tanks program (B2.1.15). In addition, aging management of the condensate storage tank (CST) and the refueling water storage tank (RWST) by the Aboveground Metallic Tanks program (B2.1.15) has been revised to be consistent with the aging management recommendations noted on Table 2 of this RAI.

   LRA Table 3.2-1, LRA Table 3.3-1, Table 3.4-1, Section A1.14, Section A1.15, Section B2.1.14 and Section B2.1.15 have been revised as shown in Amendment 28 in Enclosure 2 to be consistent with Table 1 of RAI 3.0.3-3 and Table 2 of this RAI for aging management of the FWSTs, CST, and RWST. In addition, aging evaluations for the FWSTs, CST, and RWST have been revised consistent with LR-ISG-2012-02 in the following systems as noted in LRA Chapter 3.

   - Table 3.2.2-5, High Pressure Coolant Injection System.
   - Table 3.3.2-20 Fire Protection System
   - Table 3.4.2-6, Condensate Storage and Transfer System.

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table “Amendment 28, LRA Changes for LRA Annual Update and RAI Set 28” for a description of LRA changes with this response.

RAI 3.0.3-5

Background:

Recent industry OE and questions raised during the staff's review of several LRAs has resulted in the staff concluding that several AMPs and AMR items in the LRA may not or do not account for this OE.

Issue: Corrosion under insulation

During a recent license renewal AMP audit, the staff observed extensive general corrosion (i.e., extent of corrosion from a surface area but not depth of penetration perspective) underneath the insulation removed from an auxiliary feedwater suction line. The process fluid temperature was below the dew point for sufficient duration to accumulate condensation on the external pipe surface. NACE, International (NACE), formerly known as National Association of Corrosion Engineers, Standard SP0198-2010, "Control of Corrosion under Thermal Insulation and Fireproofing Materials - A Systems Approach," categorizes this as corrosion under insulation (CUI). In addition, during AMP audits the staff has identified gaps in the proposed aging management methods for insulated outdoor tanks and piping surfaces. To date, these gaps have been associated with insufficient proposed examination of the surfaces under insulation.

The staff believes that periodic representative inspections of in-scope insulated components where the process fluid temperature is below the dew point or where the component is located outdoors should be conducted. The timing, frequency, and extent of inspections should be as follows:

a. Periodic inspections should be conducted during each 10-year period of the PEO.

b. For a representative sample of outdoor components, except tanks, and any indoor components operated below the dew point, remove the insulation and inspect a minimum of 20 percent of the in-scope piping length for each material type (i.e., steel, stainless steel, copper alloy, aluminum), or for components where its configuration does not conform to a 1-foot axial length determination (e.g., valve, accumulator), 20 percent of the surface area. Alternatively, remove the insulation and inspect any combination of a minimum of 25 1-foot axial length sections and components for each material type. Inspections are conducted in each air environment (e.g., air-outdoor, moist air) where condensation or moisture on the surfaces of the component could occur routinely or seasonally. In some instances, although indoor air is conditioned, significant moisture can accumulate under insulation during high humidity seasons.

c. For a representative sample of outdoor tanks and indoor tanks operated below the dew point, remove the insulation from either 25 1-square-foot sections or 20 percent of the surface area and inspect the exterior surface of the tank. The sample inspection points should be distributed such that inspections occur on the tank dome, sides, near the bottom, at points where structural supports or instrument nozzles penetrate the insulation, and where water collects such as on top of stiffening rings.

d. Inspection locations should be based on the likelihood of CUI occurring (e.g., alternate wetting and drying in environments where trace contaminants could be present, length of time the system operates below the dewpoint).

e. Removal of tightly adhering insulation that is impermeable to moisture is not required unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of CUI is low for tightly adhering insulation. Tightly adhering insulation should be considered to be a separate population from the remainder of insulation installed on in-scope components. The entire population of in-scope piping that has tightly adhering insulation should be visually inspected for damage to the moisture barrier with the same frequency as for other types of insulation inspections. These inspections would not be credited towards the inspection quantities for other types of insulation.

f. Subsequent inspections may consist of examination of the exterior surface of the insulation for indications of damage to the jacketing or protective outer layer of the insulation when the following conditions are verified in the initial inspection:

   i. no loss of material due to general, pitting or crevice corrosion, beyond that which could have been present during initial construction, and
   ii. no evidence of SCC.

   If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or there is evidence of water intrusion through the insulation (e.g. water seepage through insulation seams/joints), periodic inspections under the insulation should continue as described above.

   The staff noted that the removal of insulation to inspect the condensate storage tank and refueling water storage tank external surfaces was addressed in SER Section 3.0.3.2.8. The staff's review of these changes to the LRA confirmed that the proposed approach is consistent with this RAI.

<u>Request:</u>

State why conducting inspections in accordance with the current provisions in the LRA provides reasonable assurance that despite the potential for CUI, the intended function(s) of insulated outdoor components or indoor components operated below the dew point will be maintained consistent with the CLB for the PEO. If necessary, provide revisions to LRA Section 3 Table 2s, Appendix A, and Appendix B.

<u>Callaway Response</u>

The response is provided by responding to RAI issues 6.a. through f.

During the PEO, there will be periodic inspections of the potentially susceptible in-scope mechanical component surfaces under insulation and the insulation exterior surface. Insulated components exposed to a plant indoor air environment (with process fluid temperature below the dew point) and outdoor components will be inspected. Callaway has procedural controls for jacketing and insulation. The External Surfaces Monitoring of Mechanical Components program will include the following periodic inspections.

a. Periodic inspections of the potentially susceptible in-scope mechanical component surfaces under insulation and the insulation exterior surface will be conducted during each 10 year period in the PEO.

b. Insulation is removed for visual inspection of the component surface for a representative sample of outdoor components, except tanks, and indoor components, except tanks. Inspections include a minimum of 20% of the in-scope piping length for each material type (steel, stainless steel, and copper alloy). For components with a configuration which does not conform to a one foot axial length determination (e.g. valve, accumulator), 20% of the surface area is inspected. Inspected components are 20% of the population of each material type with a maximum of 25. Alternately, insulation is removed and a minimum of 25 inspections are performed that can be a combination of one foot axial length sections and individual components for each material type. Inspections are conducted in outdoor air environments and plant indoor air environments where condensation or moisture on the surfaces of the component could occur routinely or seasonally.

c. The exterior surface inspections including removal of insulation for the refueling water storage tank (RWST) and condensate storage tank (CST) are managed by the Aboveground Metallic Tanks program (B2.1.15) and are addressed in Callaway SER Section 3.0.3.2.8. Other than the RWST and CST, there are no outdoor insulated tanks or indoor insulated tanks operated below dew point that are within the scope of license renewal.

d. Inspection locations are based on the likelihood of corrosion under insulation (CUI) occurring. For example, CUI is more likely for components experiencing alternate wetting and drying in environments where trace contaminants could be present and for components that operate for long periods of time below the dew point. The following areas are potentially susceptible to CUI and will be considered for inspection:

    - Colder supply piping
    - Piping segments with thinner insulation
    - Insulation breaks, missing or damaged insulation
    - At the bottom of vertical piping runs
    - Areas exposed to mist overspray from cooling towers
    - Areas exposed to steam vent/leaks or process vents/spills
    - Deadlegs or attachments that protrude from insulated piping and operate at a different temperature than the active line

e. Tightly adhering insulation should be impermeable to moisture and does not require removal for inspection unless there is evidence of damage to the moisture barrier. If the moisture barrier is intact, the likelihood of corrosion under insulation is low for tightly adhering insulation. Tightly adhering insulation will be considered as a separate population from the remainder of the insulation installed on in-scope components. The entire population of in-scope piping that has tightly adhering insulation will be visually inspected for damage to the moisture barrier with the same frequency as for the other types of insulation inspections. These inspections would not be credited towards the inspection quantities for other types of insulation.

f. Subsequent inspections will consist of an examination of the exterior surface of the insulation for indications of damage to the jacketing or protective outer layer of the insulation, if the following conditions are verified in the initial inspection:

- No loss of material due to general, pitting or crevice corrosion, beyond that which could have been present during initial construction
- No evidence of cracking due to SCC

If the external visual inspections of the insulation reveal damage to the exterior surface of the insulation or there is evidence of water intrusion through the insulation (e.g., water seepage through insulation seams/joints), periodic inspections under the insulation will continue as described above.

LRA Table 3.2-1 item 69 and item 71, LRA Table 3.3-1 item 132, LRA Table 3.4-1 item 63 through item 65, LRA Appendix A1.21, LRA Table A4-1 item 17, and LRA Appendix B2.1.21 have been revised as shown in Amendment 28 in Enclosure 2 to provide periodic inspections of the in-scope mechanical component surfaces under insulation and the insulation exterior surface by the External Surfaces Monitoring of Mechanical Components program (B2.1.21). In addition aging evaluations for insulated components exposed to condensation have been added to the following systems as noted in LRA Chapter 3.

- Table 3.2.2-2, Containment ILRT System.
- Table 3.2.2-4, Containment Purge System.
- Table 3.2.2-5, High Pressure Coolant Injection System.
- Table 3.3.2-4, Essential Service Water System.
- Table 3.3.2-10, Chemical and Volume Control System.
- Table 3.3.2-11, Control Building HVAC System.
- Table 3.3.2-13, Auxiliary Building HVAC System.
- Table 3.3.2-14, Fuel Building HVAC System.
- Table 3.3.2-15, Miscellaneous Buildings HVAC System.
- Table 3.3.2-19, Containment Cooling System.
- Table 3.3.2-28, Miscellaneous Systems In Scope Only for Criterion 10 CFR 54.4(a)(2): Central Chilled Water System
- Table 3.3.2-28, Miscellaneous Systems In Scope Only for Criterion 10 CFR 54.4(a)(2): Domestic Water System
- Table 3.4.2-2, Main Steam Supply System.
- Table 3.4.2-3, Main Feedwater System.
- Table 3.4.2-6, Condensate Storage and Transfer System.

Corresponding Amendment Changes

Refer to the Enclosure 2 Summary Table “Amendment 28, LRA Changes for LRA Annual Update and RAI Set 28” for a description of LRA changes with this response.