Enclosure to
ULNRC-06818

Response to Request for Additional Information Regarding License Amendment Request For Permanent Extension of Type A and Type C Leak Rate Test Frequencies

17 Pages Follow

RESPONSE TO

REQUEST FOR ADDITIONAL INFORMATION REGARDING

LICENSE AMENDMENT REQUEST FOR

PERMANENT EXTENSION OF TYPE A AND TYPE C LEAK RATE TEST FREQUENCIES

The following is from the NRC's Request for Additional Information transmitted via e-mail on April 5, 2023 (ADAMS Accession No. ML23096A007).

Background

By letter dated November 3, 2022 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML22307A310), Ameren Missouri (Union Electric Company, the licensee) submitted a license amendment request (LAR) for Callaway Plant, Unit 1. The proposed LAR would revise the Technical Specifications (TS) 5.5.16, “Containment Leakage Rate Testing Program,” to allow for the permanent extension of the Type A Integrated Leak Rate Testing (ILRT) and Type C Leak Rate Testing frequencies based on the guidance in NEI 94-01, “Industry Guideline for Implementing Performance-Based Option of 10 CFR 50, Appendix J,” (Revision 3-A).

Specifically, the proposed change will revise Callaway Plant's TS 5.5.16 by replacing the references to Regulatory Guide 1.163, "Performance-Based Containment Leak-Test Program," with a reference to NEI 94-01, Revision 3-A, dated July, 2012, and the limitations and conditions specified in NEI 94-01, Revision 2-A, dated October 2008, as the documents used to implement the performance-based containment leakage testing program in accordance with Option B of 10 CFR 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors."

Request for Additional Information (RAI)

After reviewing the Licensee’s request, the U.S. Nuclear Regulatory Commission (NRC) staff has determined additional information is required to complete its review. The requests are described below.

NRC Requests and Ameren Missouri Responses

Each NRC request (RAI) is repeated below. The RAIs are organized by the originating NRC branch exactly as presented in the attachment to the NRC's RAI dated April 5, 2023. For each request/RAI, Ameren Missouri's response immediately follows.

SCPB RAIs:

Regulatory Basis

10 CFR 50.54(o) requires primary reactor containments for water-cooled power reactors to be subject to the requirements of Appendix J to 10 CFR 50. Appendix J specifies containment leakage testing requirements, including the types required to ensure the leak-tight integrity of the primary reactor containment and systems and components which penetrate the containment. In addition, Appendix J discusses leakage rate acceptance criteria, test methodology, frequency of testing and reporting requirements for each type of test. The testing requirements in Appendix J ensure that: (a) leakage through containments or systems and components penetrating containments does not exceed allowable leakage rates specified in the TSs, and (b) integrity of the containment structure is maintained during the service life of the containment. Section V.B.3 of 10 CFR 50, Appendix J, Option B, requires the licensee to develop a performance-based leakage-testing program using the RG or other implementation document and referencing it in the plant TS. Option B specifies performance-based requirements and criteria for preoperational and subsequent leakage rate testing. These requirements are met by:

1. Type A tests to measure the containment system overall integrated leakage rate,
2. Type B pneumatic tests to detect and measure local leakage rates across pressure retaining leakage-limiting boundaries such as penetrations, and
3. Type C pneumatic tests to measure containment isolation valve leakage rates.

RAI-SCPB-01:

On May 28, 1996, the NRC approved Amendment No. 111 to the facility operating license for Callaway, which allowed the implementation of Option B to 10 CFR Part 50, Appendix J. This allowed for the implementation of a performance-based option for determining the test frequency for containment leakage rate testing in accordance with RG 1.163 and American National Standards Institute/American Nuclear Society ANSI/ANS 56.8-1994, “American National Standard for Containment System Leakage Testing Requirements”.

LAR Section 3.5.6, “Type B and Type C Local Leak Rate Testing Program Implementation Review,” states that “of 65 Type B penetrations, 7% [percent] of the Type B penetrations are on extended intervals.” The staff reviewed FSAR Section 6.2.6.2 “Containment Penetration Leakage Rate Tests (Type B Tests),” which infers that all but 9 of the 65 Type B leakage rate tests are associated with electrical penetrations.

The licensee is requested to provide clarification as to why such a small percentage (i.e., 7 percent) of the Type B penetrations are on extended local leak rate test (LLRT) frequencies. Specifically, the licensee is requested to confirm that the low percentage is not an indication of poor performance.

RESPONSE:

The electrical penetrations were inadvertently omitted from the calculation of the Performance Summary contained in LAR Section 3.5.6. The Performance Summary contained in LAR Section 3.5.6 has hereby been revised to include the electrical penetrations as follows:

> Of 65 Type B penetrations, 90% of the Type B penetrations are on extended intervals.
>
> Of 109 Type C tested components, 59% of the Type C components are on extended intervals.

RAI-SCPB-2

The staff reviewed LAR Table 3.5.6-1, “Callaway Types B and C LLRT Combined As-Left Trend Summary,” and identified that it does not include results for the "as-found" minimum pathway leakage rates for the subject refueling outages nor results for the percentage of 0.6 L_a (percent/24 hours).

The staff notes that the "as-found" minimum pathway leakage rates from the current refueling outage (i.e., when combined with “as left” maximum pathway leakage rates from the previous two or three refueling outages corrected for understatement where appropriate) are the true measure of the effectiveness of the Licensee’s Type B and Type C penetration maintenance program.

For the subject refueling outages, the staff requests that the licensee provide the summation results for the "as-found" minimum pathway leakage rates. These results should be conveyed in standard cubic centimeters per minute (sccm). In addition, the staff requests these results also be conveyed as a percentage of 0.6 L_a, which is the maximum allowable leakage rate at design pressure for all Type B and Type C penetrations tested. More precisely, the combined leakage rate for "as-found" minimum pathway leakage rates from the current refueling outage [i.e., when combined with “as left” maximum pathway leakage rates from the previous two or three refueling outages corrected for understatement where appropriate] of all Type B and Type C tested penetrations must be less than or equal to 0.6 L_a.

This additional information is needed to support a staff conclusion that the Callaway plant has demonstrated a history of adequate Appendix J Type B and Type C component maintenance.

RESPONSE:

LAR Section 3.5.6 and Table 3.5.6-1 have hereby been revised to incorporate As-Found Minimum Pathway Leakage Rate (MNPLR) results for each respective refueling outage as follows:

A review of the As-Left test values for Callaway can be summarized as follows:

- As-Found MNPLR leak rate shows an average of 13.1% of 1.0 La with a high of 27.9% of 1.0 La following the completion of RF21 repair activities.
- As-Left MNPLR leak rate shows an average of 9.94% of 1.0 La with a high of 13.0% of 1.0 La following the completion of RF21 repair activities.
- As-Left Maximum Pathway Leakage Rate (MXPLR) shows an average of 14.9% of 1.0 La with a high of 18.6% of 1.0 La following the completion of RF21 repair activities.

Table 3.5.6-1
Callaway Types B and C LLRT Combined As-Found, As-Left Trend Summary

Outage & Year	**RF19 2013**	**RF20 2014**	**RF21 2016**	**RF22 2017**	**RF23 2019**	**RF24 2020**	**RF25 2022**
As-Found MNPLR (sccm)	102,133.9	90,015.13	197,825.5	36,708.53	33,308.02	32,516.5	117,268.42
%1.0 L_a	24.3	21.4	47.1[1]	8.7	7.9	7.7	27.9
As-Left MXPLR (sccm)	105,979.08	170,116.74	53,139.63	77,988.19	67,624.8	56,091.93	57,724.19
%1.0 L_a	25.2	40.5[1]	12.7	18.6	16.1	13.4	13.7
As-Left MNPLR (sccm)	90,310.17	149,231.5	40,832.79	54,694.91	35,493.52	44,411.35	33,681.04
%1.0L_a	21.5	35.5	9.7	13.0	8.4	10.6	8.0

1. During RF20, the overall Types B and C containment penetration leakage rate was more than the Maintenance Rule (MR) limit of 0.4 L_a (168,018.4 sccm). Refer to Sections 3.6.6, "Containment Isolation System (SM) Exceeded the Maintenance Rule Performance Criteria – RF20," and 3.6.7, "Local Leak Rate Testing Program Effectiveness," of the LAR.

<u>RAI-SCPB-3</u>

LAR Section 3.6.7, “Local Leak Rate Testing Program Effectiveness,” Example #3 details a long-lived and still to be resolved problem with Essential Service Water primary containment penetrations 28, 29, 71 and 73.

The staff reviewed Table 3.5.6-1, “Callaway Types B and C LLRT Combined As-Left Trend Summary,” and found that the problem existed during refueling outage RF20 of 2014. During the subsequent RF21 of 2016, the As-Left MXPLR was dramatically reduced for reasons not sufficiently explained in the LAR from 170,116.74 sccm to 53,139.63 sccm.

LAR Section 3.6.6, “Containment Isolation System (SM) Exceeded the Maintenance Rule (MR) Performance Criteria – RF20 (2014),” concludes:

> … All of these performance requirements are currently satisfied with one exception: the Containment Leakage for Type B and C tests shall be less than or equal to 0.4 L_a which equates to 168,018.4 SCCM.

“Discussion or Explanation of Event” as contained in Example #3 of LAR Section 3.6.7, indicates that as early as 2013 (RF19) there have been LLRT testing issues associated with these four penetrations. This same “Discussion” also reads in part:

> The issue with EFV0343, 344, 345 and 346 started in RF17*[sic … 2010]*. During RF17, it was identified that the valve seats in these valves were so worn that isolation was not occurring to support an LLRT of the valves in penetrations 28, 29, 71, and 73.

This “Discussion” concluded with the paragraph:

> After RF20, HI *[sic … Health Issue]* 2014019 was written to attain replacement valves. This combined with the Appendix J program being MR (a)(1) produced the necessary priority to attain replacement valves. Currently, BOM 403172 is in process to obtain vendor quotes to attain replacement valves. The work of replacement is floating between RF22 *[sic 2017]* and RF23 *[sic 2019]*.

LAR Section 3.6.7 concluded that:

> Table 3.5.6-1, “Callaway Types B and C LLRT Combined As-Left Trend Summary,” shows the effectiveness of the corrective actions taken to address LLRT Program Effectiveness.

For the Type C testing associated with penetrations 28, 29, 71, and 73, the staff notes that the conclusion for Section 3.6.7 is not supported by the corrective actions dating back to 2010. The licensee is requested to provide additional information to adequately support the conclusion of Section 3.6.7 for these penetrations.

<u>RESPONSE:</u>

Penetrations 28, 29, 71, and 73 have had issues with corrosion and performance of the valves associated with these penetrations. Those issues have impacted ILRT, LLRT testing and required repairs. In Refuel 6 (RF6) (fall of 1993), Callaway implemented a 1991 approved design change, i.e., modification package MP 91-1004, which installed double offset stainless steel valves. This eliminated the corrosion issues with the containment isolation valves and helped with the seat leakage. However, the modification did not completely resolve the seat leakage issues since the issue had more to do with the water and residual carbon steel piping than the valves themselves.

Prior to implementing MP 91-1004, there were issues related to the original piping design of the system. Unlike many other Type C penetrations, these penetrations did not have supporting manual boundary valves; therefore, valve-specific leakage rates could not be obtained. Leakage rates could be measured for the pair of supply line valves (Penetrations 28 and 71) and for the three valves in the return line valves (Penetrations 29 and 73), but the leakage rates could not be split between the valves. Thus, it was not possible to determine which valve(s) needed repair when high leakage was measured. As a result, two or three valves would have to be removed from the system in order to work on them.

Prior to initial startup of the plant in 1984, modification (MP 84-0434) was initiated to install carbon steel, manual boundary valves, i.e., valves EJV0343, 344, 345, and 346, just upstream of Penetrations 28 and 71 and just downstream of Penetrations 29 and 73. After installation (in RF3), the containment isolation valves could be split for testing while only having to drain half of the system.

Per the original scope of modification MP 84-0434, the intent was to install two valves in the lines from the isolation valves to the containment coolers, one to support LLRT testing and valve maintenance and the other to isolate containment coolers to support maintenance. The design was changed to not install the cooler isolation valves, which resulted in four spare boundary isolation valves being available (as replacements or for spare parts) to address degradation and challenges due to the water, entrained silt, debris, and corrosion seen for the above-noted valves. All of the four spare valves were subsequently utilized.

For installation during RF21, Callaway had replacement valves manufactured for EJV0343, 344, 345, and 346 using 316 stainless steel. The seats were susceptible to flow wear but not to the same degree of degradation seen for the all-carbon steel valves. In RF21, the new valves were installed. This enabled determination of which valves to work on for penetrations 28, 29, 71 and 73. Since installation, stainless steel replacement valves have generally performed satisfactorily, but the raw water continues to be a challenge with respect to degradation of the seats. One of the valves was replaced in the last refuel (RF25) because it could not isolate due to valve seat degradation.

As a result of the described operating history, the following valves have been placed on a test frequency such that they are tested every refueling outage. If an adverse step change is identified or the administrative limit is exceeded, a Condition Report and a repair job to perform the required maintenance is initiated. The performance bases eligibility report states that these penetrations cannot be placed on extended test intervals.

- Penetration 28, EFHV0032, EFHV0034
- Penetration 29, EFHV0046, EFHV0048, EFHV0050
- Penetration 71, EFHV0031, EFHV0033
- Penetration 73, EFHV0045, EFHV0047, EFHV0049

The As-Left MXPLR performance summation for penetrations 28, 29, 71, and 73 and the comparison with the As-Left MXPLR, for each outage, is as follows:

Table RAI-SCPB-3 Callaway Type C LLRT As-Left MXPLR Trend Summary for Penetrations 28, 29, 71 and 73							
Outage & Year	**RF19 2013**	**RF20 2014**	**RF21 2016**	**RF22 2017**	**RF23 2019**	**RF24 2020**	**RF25 2022**
Pen 28 MXPLR (sccm)	1748	1748	3512	1656.61	1814.23	1814	1883.64
Pen 29 MXPLR (sccm)	2606	27600	198	204.42	9668.9	7631	14036.91
Pen 71 MXPLR (sccm)	13780	19790	1232.3	5568.3	1444.6	1231	1243.44
Pen 73 MXPLR (sccm)	40900	50800	5568.3	6007.17	13694	1444.6	120.6
As-Left Type B & C MXPLR from Table 3.5.6-1 (sccm)	105,979.08	170,116.74	53,139.63	77,988.19	67,624.8	56,091.93	57,724.19
%1.0 L_a	25.2	40.5	12.7	18.6	16.1	13.4	13.7

A comparison of the As-Left MXPLR for Penetrations 28, 29, 71 and 73 to the As-Left Type B & C MXPLR for each penetration following the completion of RF21 repair activities shows the effectiveness of the corrective actions taken to address LLRT Program Effectiveness. Despite the noted improvements for these penetrations, leakage testing will continue to be performed at a frequency of every refueling outage.

<u>ESEB RAIs</u>

<u>RAI-ESEB-1</u>

<u>Background</u>:

In Section 3.6, "Operating experience (OE)," of the LAR, the site specific and industry events were evaluated for impacts on the Callaway containment that included Regulatory Issue Summary (RIS) 2016-07:

> Containment Shell or Liner Moisture Barrier Inspection," in Subsection 3.6.5 of the application. The licensee states in Subsection 3.6.5: "Callaway does not have a moisture barrier seal that adjoins the concrete floor to the liner plate. Rather, a one-foot-

thick fill slab is installed over the liner plate at both the 2000' elevation floor of containment and the 1970' elevation floor of the incore tunnel area in containment. The fill slab is installed directly over the horizontal liner plate on the floor, and directly against the vertical liner plate on the wall."

In Table 3.5.2-1, "Subsection IWE Summary Table," of the LAR, the licensee identifies Item Number E1.30, "Moisture Barrier," referring to "Note 6," under "Relief Request of Reference Number," which states, "The Callaway containment design does not include wetted surfaces of submerged areas or moisture barrier." In Table 3.5.2.-4, "Containment Inspection Relief Request," of the LAR, the licensee states, "No IWE Relief Requests have been submitted at this time."

As described in RIS 2016-07, the NRC staff identified several instances in which containment shell or liner moisture barrier materials were not properly inspected in accordance with American Society of Mechanical Engineers (ASME) Code Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," Subsection IWE, Table IWE-2500-1, "Examination Category E-A, Containment Surfaces," Item E1.30. Note 4, where Figure IWE-2500-1, "Examination Area for Moisture Barriers," shows examinations areas of typical moisture barrier.

Regulatory Basis:

10 CFR 50.55a, "Codes and standards," paragraph (g), "Inservice inspection requirements," requires, in part, that licensees implement an inservice inspection program for metal containments and metallic liners of concrete containments. The program shall be in accordance with the latest edition and addenda of Subsection IWE of Section XI of the ASME Code that has been incorporated by reference in 10 CFR 50.55a(b) 12 months before the start of the 120-month inspection interval and is subject to the applicable conditions in 10 CFR 50.55a(b)(2)(ix).

10 CFR 50.55a, "Codes and standards," paragraph (b)(2)(ix)(K), "Metal Containment Examinations," states, in part, "A general visual examination of containment leak chase channel moisture barriers must be performed once each interval, in accordance with the completion percentages in Table IWE 2411–1 of the 2017 Edition."

Section XI of ASME Code, Item E1.11, in Table IWE-2500-1 (E-A), "Examination Category E-A, Containment Surfaces," requires general visual examination of 100 percent of accessible surface areas during each inspection period, while Item E1.30 in the same table requires general visual examination of 100 percent of accessible moisture barriers during each inspection period. Note 4 (Note 3 in editions before 2013) for Item E1.30 under the "Parts Examined" column states, "Examination shall include moisture barrier materials intended to prevent intrusion of moisture against inaccessible areas of the pressure retaining metal containment shell or liner at concrete-to-metal interfaces and at metal-to-metal interfaces which are not seal-welded. Containment moisture barrier materials include caulking, flashing, and other sealants used for this application."

Issue:

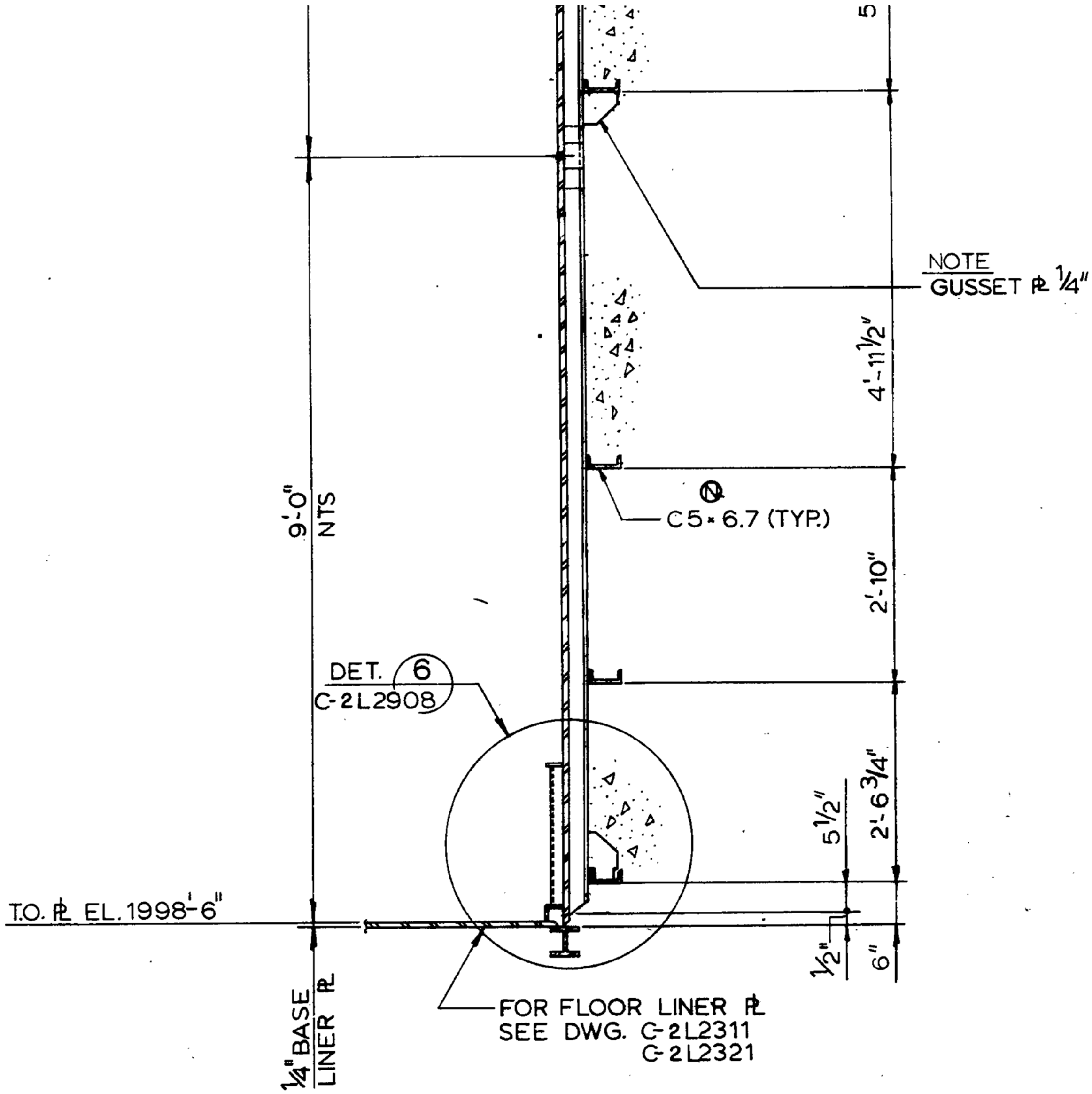
Regarding the interface between the installed concrete fill slab and the vertical liner plate on the containment wall, it is not clear how moisture intrusion into inaccessible areas of the pressure retaining containment liner under the slab will be prevented without some type of moisture barrier material.

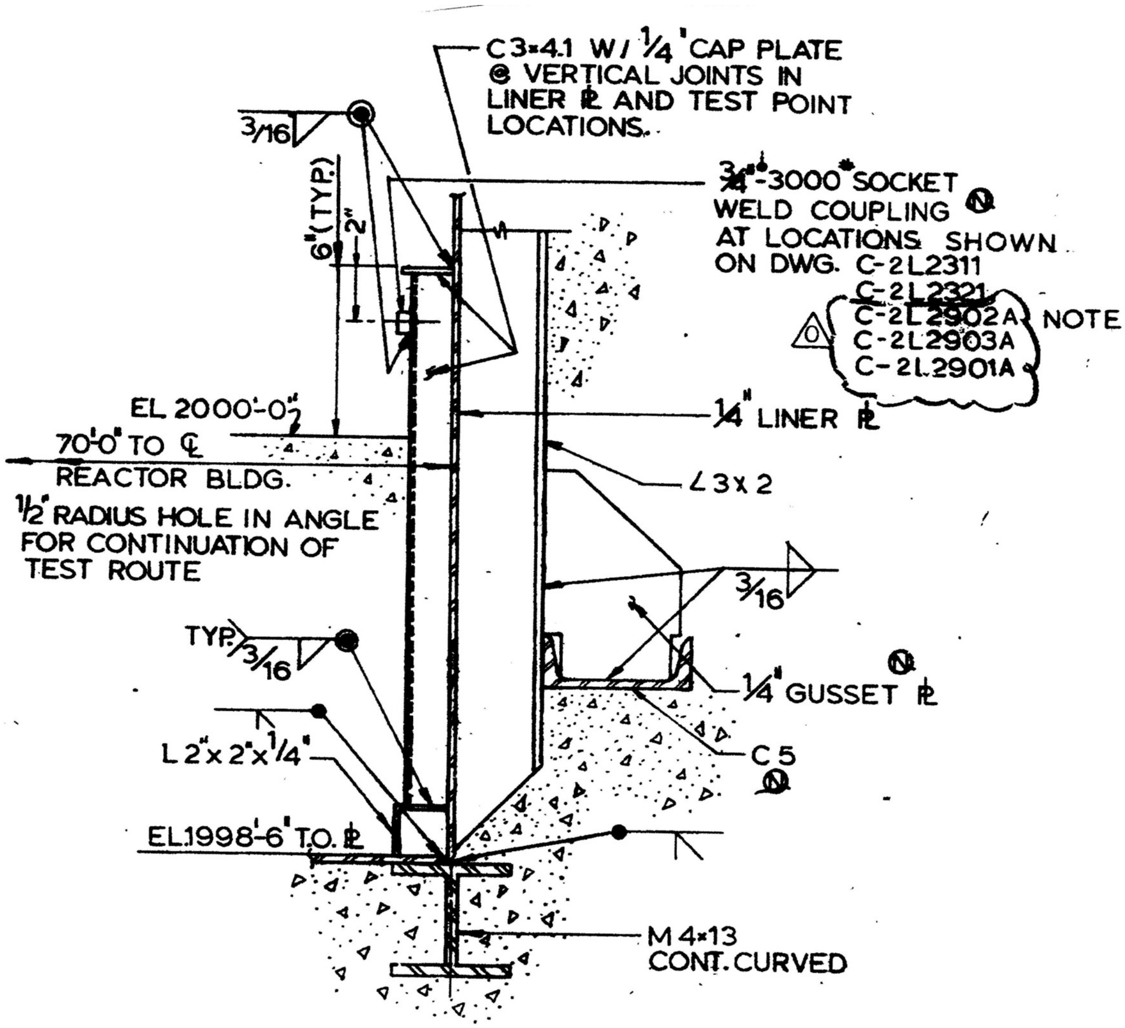
Request:

Describe the interface design at the installed concrete fill slab directly against the vertical liner plate on the containment wall and describe any features that prevent intrusion of moisture into inaccessible areas of the pressure retaining metal containment liner under the slab.

Response:

The interface design is shown on the following excerpts from Reactor Building Liner Plate and Wall Detail drawings:


NOTE
GUSSET ℞ 1/4"
4'-11 1/2"
9'-0"
NTS
C5 × 6.7 (TYP.)
2'-10"
DET. 6
C-2L2908
5 1/2"
2'-6 3/4"
T.O. ℞ EL. 1998'-6"
1/2"
6"
1/4" BASE
LINER ℞
FOR FLOOR LINER ℞
SEE DWG. C-2L2311
C-2L2321



TYPICAL LEAK CHASE ADJACENT TO WALL

DETAIL 6 / C-2L2908

SCALE 3" = 1'-0"

As stated in part in LAR Section 3.6.4:

> Any moisture introduced to the containment concrete floor to steel liner interface at the 2000' elevation, a possible location for water intrusion, would be conveyed away from the liner as the floor is sloped at all points around containment away from the steel liner. Also, no cracks or openings between the concrete floor and steel liner have been identified.
>
> The steel liner to concrete floor interface is also inspected every 18 months (every refuel) under the Coatings Aging Management Program and every 4.5 years (every 3 refuels) under the Structural Monitoring Aging Management Program. The inspection under the Structural Monitoring Aging Management Program was completed in RF20 with no identified issues related to Information Notice 2014-07, "Degradation of Leak Chase Channel Systems for Floor Welds of Metal Containment Shell and Concrete Containment Metallic Liner."

The ASME Section XI IWE Containment Pressure Boundary Inspection procedure requires the following augmented inspections:

> Surface areas likely to experience accelerated degradation and aging require augmented examinations and include areas such as the following per IWE-1241:
>
> - Interior and exterior containment surface areas subject to accelerated corrosion with minimal or NO corrosion allowance or areas where the absence or repeated loss of protective coatings has resulted in substantial corrosion and pitting. Typical locations of such areas are those exposed to standing water, repeated wetting and drying, persistent leakage, and those with geometries that permit water accumulation, condensation, and microbiological attack. Such areas may include penetration sleeves, surfaces wetted during refueling, concrete-to-steel shell or liner interfaces, embedment zones, leak chase channels, drain areas, or sump liners.

Currently, Callaway has not identified any Subsection IWE components that require augmented examination.

RAI-ESEB-2

Background:

In Subsection 3.1.2, “Post-Tensioning System,” the licensee states, “The tendon duct provides an enclosed space surrounding each tendon. After stressing, a petroleum-based corrosion inhibitor is pumped into the duct.” However, the licensee did not provide any discussion of what acceptance criteria is being used for the petroleum-based corrosion inhibitor in the ducts, which is an integral part of the containment tendon system. The licensee also describes acceptance criteria sporadically for Types A, B, and C tests, IWE, IWL tendon tensioning test, liner coating, throughout the LAR and did not refer to and/or provide the Callaway procedures outlining the actual inspection procedures and, specifically, the examination acceptance criteria.

Regulatory Basis:

10 CFR 50, Appendix J "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors Background," provides the test requirements and acceptance criteria for preoperational and periodic leakage rate testing of the reactor containment and of systems and components which penetrate the containment.

10 CFR 50.55a and 10 CFR 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criteria (GDC) 1, as they relate to concrete containment being designed, fabricated, erected, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed.

10 CFR 50, Appendix A, GDC 16, as it relates to the capability of the concrete containment to act as a leak-tight membrane to prevent the uncontrolled release of radioactive effluents to the environment.

ASME Section III, Subsection IWL, Sub-article IWL-2525, "Examination of Corrosion Protection Medium and Free Water," specifies the acceptance limits of a grease sample removed, analysis, removal/replacement from the required tendons, and acceptance limits (Table IWL-2525-1).

Issue:

The licensee did not clearly define and describe the inspection procedures and examination acceptance criteria for Types A, B and C tests, the IWE and IWL examinations, the containment liner coating, and the petroleum-based corrosion inhibitor.

Request:

Provide on the portal or clearly describe the Callaway inspection procedures and the examination acceptance criteria for Types A, B, and C tests, the IWE and IWL examinations, the containment liner coating, and the petroleum-based corrosion inhibitor.

Response:

Examination acceptance criteria for Types A, B, and C tests:

Per Technical Specification (TS) 5.5.16.d, the leakage rate acceptance criteria are as follows:

1. Containment leakage rate acceptance criterion is ≤ 1.0 L_a. During the first unit startup following testing in accordance with this program, the leakage rate acceptance criteria are < 0.60 L_a for the Type B and C tests and ≤ 0.75 L_a for Type A tests.

The above acceptance criteria for the Type A, B and C tests are specified in Callaway procedure ESP-SM-01001, "Containment Leakage Rate Testing Program," which contains the overall programmatic controls for the containment leakage rate testing program. For the Type A test, this procedure refers to ESP-GP-01007, "Reactor Building Integrated Leak Rate Test – IPTE," for the applicable test acceptance criteria (including ANSI 56.8 stabilization criteria, etc.). ESP-SM-01001 also identifies and refers to the individual local leak rate test procedures that provide input to the total Type B and C leakage rates and which include the applicable administrative limits for the various containment penetrations.

The examination acceptance criteria for IWE and examinations are specified in Callaway procedure ESP-ZZ-01016, "ASME Section XI IWE Containment Pressure Boundary Inspection," as follows:

<u>General Visual of Pressure Retaining Surfaces and Bolted Connections</u>

Pressure boundary surfaces and pressure retaining bolted connections having NONE of the following indications as listed in IWE-3511 are acceptable for continued service:

- No evidence of damage or degradation sufficient to warrant further evaluation or performance of a repair/replacement activity. Suspect conditions shall be evaluated to the extent necessary to ensure that the component function is not impaired.

Painted or coated surfaces must be free of blistered, flaking, or peeling paint, excessive corrosion, and other signs of distress.

All other surfaces and pressure retaining bolting must be free of excessive corrosion, bulges, deformation, and other signs of distress.

<u>VT-1 of Pressure Retaining Bolted Connections</u>

Bolted connections having NONE of the following indications as listed in IWB-3517.1 are acceptable for continued service:

- Nonaxial crack-like flaws that exceed¼ inch in length
- Axial orientated crack-like flaws that exceed 1 inch in length. (Defects which may cause the bolted connection to violate either the leak tight or structural integrity as referenced in accordance with the bolting material specification)
- More than one deformed or sheared thread in the zone of thread engagement of bolts, studs, or nuts
- Localized general corrosion that reduces the bolt or stud cross-sectional area by more than 5%
- Bending, twisting, or deformation of bolts or studs to the extent that assembly or disassembly is impaired
- Missing or loose bolts, studs, nuts, or washers
- Fractured bolts, studs, or nuts
- The threads of any bolt or stud NOT engaged for the full length of threads in the nut (i.e., flush)
- Degradation of protective coatings on the surface
- Evidence of coolant leakage "boric acid residue" near bolting

VT-1 of Pressure Boundary Surfaces

Pressure boundary surfaces having NONE of the following as listed in IWE-352 are acceptable for continued service:

- Pressure retaining component corrosion or erosion that exceeds 10% of the nominal wall thickness
- Loose, missing, cracked or fractured parts
- Bolting or fastener relevant conditions listed in IWB-3517.1
- Structural distortion or displacement of parts to the extent that component function may be impaired
- Moisture barrier conditions that fail to meet the acceptance standards of IWE-3512

Callaway procedure ESP-ZZ-01012, "Containment Post-Tensioning System Inspection," references Specification C-1003, "Specification of Inservice Inspection of the Containment Building Post-Tensioning System and Exterior Concrete Shell," which specifies the examination acceptance criteria as follows:

- The acceptability of concrete surface condition is in accordance with ACI 349.3R section 5.2 and 5.3. The Responsible Engineer determines that there is no evidence of damage or degradation sufficient to warrant further evaluation or repair. Concrete surface areas that are not acceptable shall be evaluated and reported by the Responsible Engineer. This evaluation and report shall state the cause of the condition that does not meet acceptance standards, the acceptability of the concrete containment building without repair of the deficient item, whether or not repair or replacement is required, and the extent and method for repair or replacement, and the extent, nature, and frequency of any additional examinations. The evaluation shall meet the requirements of 10CFR50.55a(b)(2)(viii)(E), as applicable.

  The acceptability of Anchorage Bearing Plate surfaces is determined in accordance with IWL-3221.3 and ACI 349.3R section 5.2 and 5.3.

- There shall be no presence of significant voids in the grease coverage (above 5 percent of the net duct volume), nor signs of free-standing water in the tendon sheathing.

- Wire Removal and Examination

  Wire Removal and Examination shall be in accordance with IWL-2523.1 and IWL-2523.2. One wire shall be removed for inspection and testing from each detensioned tendon. The wire shall be inspected, and the locations and levels of corrosion and any defects shall be documented. The corrosion levels shall be compared with those at installation. If the corrosion has progressed beyond level 2, one additional wire shall be removed at approximately 180° from the first wire. The corrosion levels for the surveillance as compared to the criteria used during field installation are indicated below:

Corrosion Level		Acceptability
Surveillance	Field Installation	At Installation
1	A	Acceptable
2	B, C, D	Acceptable
3, 4, 5	E	Unacceptable*

*Requires further evaluation for surveillance purposes.

The following definitions of corrosion levels for the tendon wires and anchorage components shall be used:

Corrosion Level	Description
1	No visible corrosion
2	Visible oxidation; no pitting
3	0.000" < pitting ≤ 0.003"
4	0.003" < pitting ≤ 0.006"
5	0.006" < pitting

- The lift-off force for any surveillance tendon shall be within limits.

  The calculated lift-off forces shall be compared with the appropriate data provided in the Tendon Stress Relaxation Curves and Normalization Factors. If the measured prestressing force of the selected tendon in a group lies above the prescribed lower limit, the lift-off test is considered to be a positive indication of the tendon's acceptability. If the measured prestressing force of the selected tendon in a group lies between the prescribed lower limit and 90 percent of the prescribed lower limit, two adjacent (accessible) tendons, one on each side of this tendon shall be checked for their prestressing forces. If the prestressing forces of these two tendons are above 95 percent of the prescribed lower limits for the tendons, all three tendons shall be restored to the required level of integrity, and the tendon group shall be considered as acceptable. If the measured prestressing force of any two tendons falls below 95 percent of the prescribed lower limits of the tendons, additional lift-off testing shall be done to detect the cause and extent of such occurrence.

- If the measured prestressing force of any tendon lies below 90 percent of the prescribed lower limit, the defective tendon shall be completely detensioned and additional lift-off testing shall be done so as to determine the cause and extent of such occurrence.

- The tendon lift-off shall be greater than the following average minimum effective design prestress:

  a. Vertical Tendons 139 ksi

b. Hoop Tendons:

1) Cylinder 147 ksi

2) Dome 134 ksi

- Tendon lock-off force and changes in load/elongation for any retensioned tendon:

  The jacking ram shall be pressurized to 3000 psig, and the gauge pressure, ram extension, and tension elongation shall again be documented.

  The tendon shall continue to be stressed, holding at 1000 psig increments to equalize the jacking pressure. Retension those tendons detensioned to at least the force level recorded prior to detensioning or the predicted value, whichever is greater, with the tolerance within minus zero to plus 6%, but not to exceed 70 percent of the guaranteed ultimate tensile strength of the tendons. During retensioning of these tendons, the changes in load and elongation shall be measured simultaneously at a minimum of three approximately equally spaced levels of force between zero and the seating force. If the elongation corresponding to a specific load differs by more than 10 percent from that recorded during the installation, an investigation shall be made to ensure that the difference is not related to wire failures or slip of wires in anchorages.

  The gauge reading, ram extension, and tendon elongation shall be recorded. Difference in overstress level between original installation and the current surveillance shall be within $\pm$50 psig, after correction for missing wires.

- The following are the acceptance criteria that apply to the chemical properties of the tendon grease removed. The concentration of impurities shall be:

  a. Chlorides $\leq$10 ppm

  b. Nitrates $\leq$10 ppm

  c. Sulfides $\leq$10 ppm

  d. Water $\leq$10 percent dry weight of filler

  e. Reserve Alkalinity >17.5 mg KOH/g