UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 2, 2021

Mr. David P. Rhoades
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – ALTERNATIVE TO THE REQUIREMENTS OF THE ASME SECTION XI, SUBSECTION IWL CONCERNING UNBOUND POST-TENSIONING SYSTEMS (EPID L-2020-LLR-0135)

Dear Mr. Rhoades:

By letter dated October 6, 2020 (Agencywide Documents Access and Management System Accession No. ML20280A508), Exelon Generation Company, LLC (the licensee) submitted a request to the Nuclear Regulatory Commission (NRC) for the use of an alternative to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI requirements at Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety.

As set forth in the enclosed safety evaluation, the NRC staff determines that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the proposed alternative at Calvert Cliffs for the third 10-year IWL ISI interval for a one-time deferral from 5 years to 10 years.

All other ASME Code Section XI requirements for which the alternative was not specifically requested and authorized in this proposed alternative remain applicable, including a third-party review by the authorized nuclear inservice inspector.

If you have any questions, please contact the Calvert Cliffs Project Manager, Michael Marshall, at (301) 415-2871.

Sincerely,

James G. Danna

Digitally signed by James G. Danna
Date: 2021.09.02 15:15:04 -04'00'

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosure:
Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ALTERNATIVE RELIEF REQUEST CISI-03-01 CONCERNING CONTAINMENT UNBONDED POST-TENSIONING SYSTEM INSERVICE INSPECTION REQUIREMENTS

EXELON GENERATION COMPANY, LLC

CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated October 6, 2020 (Agencywide Documents Access and Management System Accession No. ML20280A508), Exelon Generation Company (Exelon, the licensee) submitted Relief Request (RR) CISI-03-01, "Concerning Containment Unbonded Post-Tensioning System Inservice Inspection Requirements," and requested authorization of a proposed alternative request from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, Subsection IWL for Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs).

Exelon proposed to extend the interval between post-tensioning system examinations and testing and detailed visual examination of concrete adjacent to tendon bearing plates from 5 to 10 years. Also, the licensee proposed to permanently eliminate the requirement for wire extraction and testing. Exelon further proposed to limit corrosion protection medium (CPM) chemical tests to absorbed water content unless additional tests are specified by the responsible engineer.

Pursuant to the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a, "Codes and Standards," specifically 10 CFR 50.55a(z)(1), the licensee requested to use the proposed alternative to the examination requirements of the ASME Code, Section XI, Subsection IWL related to the containment unbonded post-tensioning system on the basis that the alternative provides an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(4), throughout the service life of a nuclear power facility, components that are classified as Class CC pressure retaining components must meet the requirements set forth in Section XI of the ASME Code, Subsection IWL, as incorporated by reference in paragraph (a)(1)(ii) subject to the conditions listed in paragraph (b)(2)(ix) of 10 CFR 50.55a. Section XI, Subsection IWL of the ASME Code, provides rules for in-service inspection (ISI) and repair and replacement activities of the reinforced concrete and

post-tensioning system components of Class CC containment structures. Alternatives to the requirements of 10 CFR 50.55a may be authorized by the NRC pursuant to 10 CFR 50.55a(z)(1), if the licensee demonstrates that the proposed alternative would provide an acceptable level of quality and safety.

The licensee proposed an alternative to code requirements for the examination of unbonded post-tensioning system in Table IWL-2500-1 (L-B), Examination Category L-B of the ASME Code, Section XI, Subsection IWL, and the 5-year ISI schedule (examination frequency) to extend the examination frequency to 10 years, not perform wire extraction and testing permanently, and limit CPM chemical tests to only absorbed water content unless additional tests are specified by the responsible engineer.

This alternative request is associated with the third containment inservice inspection (CISI) interval for the Calvert Cliffs. The third CISI interval complies with the 2013 Edition of the ASME Code. The third CISI interval began on July 1, 2019, and is currently scheduled to end June 30, 2029. The 45th year surveillance is required to be completed no later than September 9, 2022, for Unit 1 and September 9, 2023, for Unit 2. The 50th year surveillance for Unit 1 would be due September 9, 2026, plus or minus 1 year. The 50th year surveillance for Unit 2 would be due September 9, 2027, plus or minus 1 year. This relief request proposes to perform visual examination only of the concrete containment and accessible steel hardware visible without tendon cover removal during the 45th year surveillance. Physical testing would be performed only if visual examination results indicate a need for such testing as determined by the responsible engineer.

The licensee requested authorization for use of the proposed alternative for the third ISI interval pursuant to 10 CFR 50.55a(z)(1), on the basis that it provides an acceptable level of quality and safety, based on performance of its post-tensioning system components as supported by documented data of past plant-specific examinations and testing and operating experience.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Proposed Alternative

The licensee's proposed alternative requests for Calvert Cliffs Units 1 and 2, are applicable to the unbonded post-tensioning system components of the containment buildings. Specifically, the request is against the following examination requirements in Table IWL-2500-1 (L-B) of the ASME Code, Section XI, Subsection IWL.

- Item Number L2.10 requires that selected tendon force and elongation be measured every five years in accordance with IWL-2522.

- Item Number L2.20 requires that tendon single wire samples be removed and examined for corrosion and mechanical damage as well as tested to obtain yield strength, ultimate tensile strength, and elongation on each removed wire. This inspection must be done every five years in accordance with IWL-2523.

- Item Number L2.30 requires that a detailed visual examination on selected tendon anchorage hardware and adjacent concrete extending two feet from the edge of the bearing plate be performed every five years in accordance with IWL-2524. In addition, the quantity of free water released from the anchorage end cap, as well as any free water that drains from the tendon during examination, must be documented.

- Item Number L2.40 requires that samples of selected tendon CPM be obtained and analyzed every five years in accordance with IWL-2525.

- Item Number L2.50 requires that samples of free water be obtained and analyzed every five years in accordance with IWL-2525.

The licensee's proposed alternatives, corresponding to the above code requirements, are requested for the remainder of the current third CISI intervals for Calvert Cliffs, and to continue until the end of the current period of extended operation for each unit. The alternatives are as follows:

- Item Number L2.10: the licensee proposed to extend the interval of the examination from five years to ten years.

- Item Number L2.20: the licensee proposed to eliminate this examination and testing entirely.

- Item Number L2.30: the licensee proposed to extend the interval of the examination from five years to ten years.

- Item Number L2.40: the licensee proposed to extend the interval of the examination from five years to ten years. The licensee also proposed that routine CPM testing be limited to determination of absorbed water content and that additional tests for corrosive ion concentration and neutralization number need only be performed if corrosion or moisture conditions favoring corrosion are found, in which case tests will be performed as specified by the responsible engineer.

- Item Number L2.50: the licensee proposed to extend the interval of the examination from five years to ten years.

To demonstrate that the proposed alternative actions will provide an acceptable level of quality and safety, the licensee provided the information summarized below. The licensee also provided additional benefits to the deferral of the physical testing, such as less exposure of personnel to industrial safety hazards and undesirable conditions, and a reduction of unnecessary loading cycles on the tendons and environmental waste.

The licensee stated that ASME Section XI, Subsection IWL requires periodic visual examination and physical testing of containment building concrete as well as physical testing of post-tensioning systems. The examination and testing to date have indicated that the post-tensioning system is expected to maintain its safety-related function through the period of extended operation for Calvert Cliffs. In its request, the licensee noted that the proposed alternatives only apply to the tendon tests and associated examinations that require close-in access to tendon end anchorage areas. General visual or detailed visual examinations of accessible containment concrete surfaces, bearing plates, and tendon end caps will continue to be performed at the required five-year interval in accordance with Table IWL-2500-1 (L-A), IWL-2410 and IWL-2510. If these visual examinations reveal conditions that could indicate degradation of tendons or tendon hardware components, additional examinations per item numbers L2.10, L2.20, L2.30, L2.40, and L2.50 may be conducted, as determined and documented by the responsible engineer.

The licensee provided the following example conditions that could require removal of the tendon end cap and further examination per Item Numbers L2.10, L2.20, L2.30, L2.40, and L2.50:

- Evidence of possible damage to the enclosed post-tensioning hardware as indicated by conditions such as end cap deformation found during external visual examination. Conditions observed by removal of the end cap would determine the extent of additional examinations per Item Numbers L2.10, L2.20, L2.30, L2.40, or L2.50.

- Active corrosion on a bearing plate or end cap that requires further investigation as determined by the responsible engineer in an engineering evaluation.

- Evidence of corrosion protection medium leakage will be evaluated, and a plan developed that requires further investigation and corrective actions as defined in an engineering evaluation documented by the responsible engineer.

The licensee's request provides plant specific examination results on Calvert Cliffs, as a basis for the proposed deviations from the ASME Section XI requirements.

3.2 NRC Staff Evaluation

The NRC staff reviewed the information provided in the proposed alternative request and noted that the licensee will continue to conduct the general visual examinations, and detailed visual examination of suspect areas, on a five-year frequency as required by Table IWL-2500-1 (L-A) "Examination Category L-A, Concrete." Any indications identified during these examinations may lead to additional examinations in accordance with Table IWL-2500-1 (L-B) "Examination Category L-B, Unbound Post-Tensioning System," as determined by the responsible engineer. As required by IWL-2511, this would include examination of the concrete surfaces and tendon end anchorage areas (end caps, bearing plates, concrete in the area) on a five-year frequency to identify evidence of damage, deformation, water intrusion, corrosion, cracking or CPM leakage. Tendon end caps are required to be removed for this examination if there is evidence of tendon end cap deformation or damage. The NRC staff also reviewed the plant specific information, and summary results of examinations conducted for each of the requirements of Section XI, Subsection IWL, Table IWL-2500-1 (L-B), Item Numbers L2.10, L2.20, L2.30, L2.40, and L2.50. A summary of the NRC staff's evaluation of each Item Number is provided below.

Item Number L2.10, Tendon Force Trends and Forecasts

Calvert Cliffs has completed 10 pre-stressing system surveillances on each unit. These were based on Regulatory Guide 1.35, Revision 0, "Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containments" (ADAMS Accession No. ML12305A260), 10 CFR 50.55a, or ASME Section XI Subsection IWL. Tendon examinations and tests are currently performed in accordance with the requirements of Subsection IWL. On page 21 of the Enclosure to RR CISI-03-01, the licensee states that:

> The current mean pre-stressing force (hoop, vertical or dome), computed using both the trend of individual tendon force data acquired to date and the mean of the most recently acquired data, exceeds the minimum required level by significant margins.

and

> The forecast mean pre-stressing forces (hoop dome and vertical), determined using the data acquired to date and computed, for conservatism, at the 95% lower confidence limit, remain above the minimum required levels until well past the deadline for completion of the subsequent examination.

The NRC staff reviewed the lift-off force data and verified that the projected forces remain above the minimum required value through the next inspection and through the end of the current operating license. These data are contained in Figure 1, "Calvert Cliffs Unit 1 Hoop Tendon Force Trend & LCL / 1 - 40 Year Surveillance Results"; Figure 3, "Calvert Cliffs Unit 2 Hoop Tendon Force Trend & LCL / 1 - 35 Year Surveillance Results"; Figure 4, "Calvert Cliffs, Unit 1 Vertical Tendon Force Trend & LCL / 1 - 40 Year Surveillance Results"; Figure 5, "Calvert Cliffs, Unit 2 Vertical Tendon Force Trend & LCL / 1 - 35 Year Surveillance Results"; Figure 6, "Calvert Cliffs, Unit 1 Dome Tendon Force Trend & LCL / 1 - 40 Year Surveillance Results"; and Figure 7, "Calvert Cliffs, Unit 2 Dome Tendon Force Trend & LCL / 1 - 35 Year Surveillance Results," of the Enclosure to RR CISI-03-01.

Based on the statistical analyses of past surveillance results, and the significant margin between the measured force trend (forecast) values and the minimum required value, the NRC staff finds it acceptable to extend the interval of the post-tensioning system examinations and tests (ASME Section XI, Table IWL-2500-1(L-B), Item Number L2.10) from five years to ten years for the third 10-year Calvert Cliffs, IWL ISI intervals.

Item Number L2.20, Wire Examination and Test Results

During the 20th year (Units 1 and 2) surveillance, which commenced in May 1997, major corrosion was found at the upper ends of many vertical tendon wires. The corrosion was extensive and resulted in expanding the surveillance scope to include visual examination of all Units 1 and 2 vertical tendon anchorages as well as measurement of force in all vertical tendons. Following the completion of this surveillance, about one-third of the Unit 1 and Unit 2 tendons were either replaced or re-tensioned in 2002. As no significant degree of corrosion was found during the 15th year and earlier surveillances, it is presumed that most of the corrosion found in 1997 occurred after the 1991 completion of the 15th year surveillance.

On page 23 of the Enclosure to RR CISI-03-01, the licensee states that:

> In general, tests that conform to ASTM specifications and that are performed by experienced technicians show that both strength and elongation are reasonably close to, but exceed, the minima (240 ksi and 4%, respectively) specified for ASTM A421 wire.

The NRC staff finds that wire test results and elongation at failure for both Unit 1 and Unit 2 described in Tables 12a and 12b of the Enclosure to RR CISI-03-01, respectively, show that the mean value for all test wires from year 1 through year 40 are equal to or above 4 percent of the ASME Code's requirement except the 10th year at 2.9 percent for Unit 1. On page 45 of the Enclosure to RR CISI-03-01, the licensee states that:

> The entire length of each extracted wire was visually examined for signs of damage and corrosion. The corrosion condition of most extracted wires was judged to be Level 1 [bright metal] or 2 [light rust with no pitting] … There is no indication in any of the surveillance reports that observed corrosion was active.

Since the examination and testing of sample wires has shown no degradation of condition, strength, or the mean elongation value, and has not identified any cases of active corrosion, the NRC staff finds it acceptable to waive the requirement for sample wire removal and testing (ASME Section XI, Table IWL-2500-1 (L-B), Item Number L2.20) for the third 10-year IWL ISI Interval.

Item Number L2.30, Anchorage Hardware and Surrounding Concrete Inspection

On pages 49 and 50 of the Enclosure to RR CISI-03-01, the licensee described that each of the surveillances, sample tendon end anchorage areas were visually examined for evidence of corrosion, presence of free water, discontinuous wires, damage to or distortion of load bearing components and cracks in concrete adjacent to bearing plates and a total of more than 900 anchorage were examined. Also, they described that there was one bearing plate corrosion found during the 25th year surveillance and another bearing plate corrosion found during the 35th year surveillance. The licensee described that two discontinuous wires were reported to have Level 5 corrosion at the break locations and one test wire had a level 3 corrosion. No other significant bearing plates and wires corrosion had been found over the 14-year period covered by the last 4 surveillances.

On page 54 of the Enclosure to RR CISI-03-01, the licensee states that:

> No anchorage area concrete cracks wider than 0.01 inches have been reported.
>
> Therefore, it is concluded that cracking of concrete adjacent to tendon end anchorage bearing plates is not an issue and that close in examinations of these areas at intervals of 10 years is adequate to monitor this condition.

The NRC staff reviewed the license's presentations, discussions, and evaluations of the anchorage hardware and surrounding concrete inspection and finds it is acceptable to extend the interval between enclosed end anchorage items to 10 years from the current 5 years.

Item Number L2.40 CPM Testing

The CPM test samples were collected at the ends of sample tendons during each of the 10 surveillances. Each CPM sample was tested for the presence of three corrosive ions (chlorides, nitrates, and sulfides), absorbed water content and neutralization number. The test results are summarized below:

- with one exception, considered to be the result of sample contamination or a laboratory error, all tested samples met the Table IWL- 2525-1 10 ppm upper limit on chloride, nitrate, and sulfide ion concentration, and shows no trend of increasing over time.

- with two exceptions (documented during the Unit 1 3rd year surveillance), all tested samples met the Table IWL-2525-1 10 percent upper limit on water content and shows no trend of increasing over time.

- all tested samples are concluded to have met the Table IWL-2525-1 neutralization number criterion for reserve alkalinity, and show no trend indicating that the corrosion protection capacity of the CPM is degrading over time.

The NRC staff finds that the CPM test results summarized above support the conclusion that the interval between such tests can be extended to 10 years from the current 5 years with no adverse consequences. In addition, the NRC staff finds it is acceptable to waive the requirement to perform the tests of CPM for corrosive ions and neutralization number for the third IWL ISI Interval because these tests may not be necessary unless evidence of active corrosion is found from visual examinations of anchorage hardware/wires, or the quantity of absorbed water in the CPM has increased with time. No such conditions of significance have been found during past examinations at Calvert Cliffs.

In addition, the NRC staff finds it is acceptable to waive the requirement to perform the tests of CPM for corrosive ions and neutralization number for the third IWL ISI Interval because these tests may not be necessary unless evidence of active corrosion is found from visual examinations of anchorage hardware and wires, or the quantity of absorbed water in the CPM has increased with time. No such conditions of significance have been found during past examinations at Calvert Cliffs Nuclear.

Item Numbers L2.50 Free Water Testing

On Unit 1, free water in amounts varying from traces or water observed to approximately 1 gallon has been noted at 129 tendon anchorages including the anchorages of the 20th year surveillance expanded scope vertical tendons. Since the 20th year surveillance, only 9 observations of water have been reported. Of the amounts identified, 6 were reported as drops to 1 ounce. The remaining 3 amounts were quantified as 20 ounces and 6 ounces for the 35th year surveillance, and 76 ounces for the 40th year surveillance.

On Unit 2, free water in amounts varying from traces or water observed to approx. 2 - 3 gallons has been noted at 106 tendon anchorages including the anchorages of the 20th year surveillance expanded scope (all) vertical tendons. Since the 20th year surveillance, only 4 observations of water have been reported. Of these, one reported as 10 ounces at the 30th year surveillance, and three were reported as 3 ounces or less.

Reports documenting surveillances through the 25th year do not address testing of free water samples to determine pH values. All sample pH values collected at 30th, 35th, and 49th year surveillances for both units are greater than 7 indicating that the water collected is not corrosive. Water found in tendon ductwork during the 25th year and later surveillances caused no significant corrosion (Levels of 3 or greater) of tendon wire, anchor heads, bushings or shims.

Based on the above data, the licensee stated that future free water intrusion will not have a significant impact on post-tensioning system load bearing items and that the examination of post-tensioning system items enclosed by the end caps can be extended to 10 years with little risk of missing free water induced conditions that could impair system integrity.

The NRC staff finds that the past inspection and testing results of free water justifies the extension of inspection interval for Section XI, Subsection IWL, Table IWL-2500-1 (L-B), Item Numbers L2.50, from five years to ten years for the third 10-year IWL ISI Interval for Calvert Cliffs Nuclear Power Plant Units 1 and 2.

4.0 CONCLUSION

Based on the above evaluation, the NRC staff determines that the licensee has demonstrated adequate performance of the unbonded post-tensioning system by presenting plant-specific P-T system inspection results and operating experience, and technical evaluations demonstrating applied tendon prestress will remain acceptable through the extended inspection interval. Therefore, the NRC staff finds that the use of proposed alternative RR CISI-03-01 for the third 10-year IWL ISI interval provides an acceptable level of quality and safety.

The NRC staff approves the alternative proposal to extend the interval of the P-T examinations and tests, and the detailed visuals of adjacent concrete, for a “one-time” five years deferral to ten years (Table IWL-2500-1 (L-B), Items L2.10); and to waive the sample wire removal and testing for a “one-time” 5 years deferral (Table IWL-2500-1 (L-B) Items L2.20) to 10 years; the requirement of tendon anchorage end cap removal and the recording of the quantity of free water released from the end cap and the tendon during examination for a “one-time” 5 years deferral (Table IWL-2500-1(L-B), Item L2.30) to 10 years; the test of CPM for corrosive ions and neutralization number for a “one-time” 5 years deferral (Table IWL-2500-1(L-B), Item L2.40) to 10 years; and the test of free water sample to determine pH values for a “one-time” 5 years deferral (Table IWL-2500-1(L-B), Item L2.50) to 10 years for the third IWL ISI Interval.

However, the NRC staff does not approve the licensee’s request for the above deferrals and waivers to be made “permanent” through the period of extended operation. The NRC staff notes that the consensus standard that governs concrete containment inspections (ASME Section XI, Subsection IWL), which is developed with input from members across the nuclear industry, requires these inspections be completed on a five-year basis. The NRC staff finds it reasonable to approve a one-time interval extension, based on its review of the plant-specific operating experience provided in the relief request. However, the NRC staff does not find it reasonable to extend the inspection intervals for future ISI intervals, without reviewing updated plant-specific operating experience.

As set forth above, the NRC staff determines that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the proposed alternative at Calvert Cliffs Nuclear Power Plant, Units 1 and 2, for the third 10-year IWL ISI interval for a one-time deferral from 5 years to 10 years and does not authorize other requested items proposed by the licensee, as stated in the summary section above.

All other ASME Code Section XI requirements for which the alternative was not specifically requested and authorized in this proposed alternative remain applicable, including a third-party review by the authorized nuclear inservice inspector.

Principal Contributor: J. Ma

Date: September 2, 2021

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – ALTERNATIVE TO THE REQUIREMENTS OF THE ASME SECTION XI, SUBSECTION IWL CONCERNING UNBOUND POST-TENSIONING SYSTEMS (EPID L-2020-LLR-0135) DATED SEPTEMBER 2, 2021

DISTRIBUTION:
PUBLIC
PM File Copy
RidsNrrDorlLpl1
RidsRgn1MailCenter
RidsACRS_MailCTR
RidsNrrPMCalvertCliffs
RidsNrrLAKEntz
AMcCraw, OEDO
RRichardson, OEDO
RidsNrrDexEseb
JMa, NRR

ADAMS Accession No. ML21190A004

OFFICE	NRR/DORL/LPL1/PM	NRR/DORL/LPL1/LAiT	NRR/DORL/LPL2-1/LA	NRR/DEX/ESEB/BC
NAME	MMarshall	KEntz	KGoldstein	JColaccino
DATE	07/09/2021	07/09/2021	08/06/2021	05/24/2021
OFFICE	NRR/DORL/LPL1/BC			
NAME	JDanna			
DATE	09/02/2021			

OFFICIAL RECORD COPY