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

December 21, 2018

Mr. Bryan C. Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 – ISSUANCE OF ALTERNATIVE REQUESTS RELATED TO THE FIFTH INSERVICE INSPECTION INTERVAL (EPID L-2018-LLR-0055, EPID L-2018-LLR-0057, EPID L-2018-LLR-0058, AND EPID L-2018-LLR-0059)

Dear Mr. Hanson

By letter dated April 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18109A116), as supplemented by letters dated July 31, 2018; September 6, 2018; and November 28, 2018 (ADAMS Accession Nos. ML18109A116, ML18250A068, and ML18337A196, respectively), Exelon Generation Company, LLC (Exelon, the licensee) submitted relief requests to the U.S. Nuclear Regulatory Commission (NRC). Exelon proposed alternatives to certain inservice inspection requirements of the American Society of Mechanical Engineers Boiler & Pressure Vessel Code (ASME Code) for the Peach Bottom Atomic Power Station (Peach Bottom), Units 2 and 3 pursuant to Title 10 of the *Code of Federal Regulations* Section 50.55a(z).

Exelon submitted the following relief requests:

1. I5R-02 − Examination of Inaccessible Surfaces
2. I5R-03 – Use of BWRVIP [Boiling Water Reactor Vessel and Internals Project] Guidelines
3. I5R-04 − Alternative Nozzle-to-Vessel Weld and Inner Radii Examination
4. I5R-05 − Encoded Phases Array Ultrasonic Examination Techniques
5. I5R-06 − Examination Category B-G-1 Item No. B6.40 Threads in Flange

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), the NRC staff concluded, in the enclosed safety evaluation, that Relief Requests I5R-04, I5R-05, and I5R-06 are authorized on the basis that the proposed alternatives provide an acceptable level of quality and safety. The subject relief requests are for the fifth 10-year interval of the inservice inspection program at Peach Bottom, Units 2 and 3, which begins on January 1, 2019, and is currently scheduled to end on December 31, 2028.

Pursuant to 10 CFR 50.55a(z)(2), the NRC staff concluded, in the enclosed safety evaluation, that Relief Request I5R-02 is authorized on the basis that the proposed alternative provides a reasonable assurance of an acceptable level of quality and safety for the subject welds and has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). The

NRC staff finds that, provided the requirements from which relief is requested in I5R-02 stay the same after the fifth inservice inspection interval (third containment inservice inspection) and for the remaining term of the Peach Bottom Renewed Facility Operating Licenses, compliance with such requirements will continue to be a hardship, and the performance of the integrated leak rate testing will continue to provide reasonable assurance of structural integrity and leaktightness for the primary containment drywell penetration N-3.

By letter dated July 18, 2018 (ADAMS Accession No. ML18179A394), NRC authorized the proposed alternative Relief Request I5R-03.

If you have any questions please contact the Project Manager, Jennifer Tobin, at 301-415-2328 or Jennifer.Tobin@nrc.gov.

Sincerely,

James G. Danna Digitally signed by James G. Danna
Date: 2018.12.21 11:12:38 -05'00'

James G. Danna, Chief
Plant Licensing Branch 1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-277 and 50-278

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 REQUESTS RELATED TO THE FIFTH INSERVICE INSPECTION INTERVAL

EXELON GENERATION COMPANY, LLC

PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-277 AND 50-278

1.0 INTRODUCTION

By letter dated April 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18109A116), as supplemented by letters dated July 31, 2018; September 6, 2018; and November 28, 2018 (ADAMS Accession Nos. ML18109A116, ML18250A068, and ML18337A196, respectively), Exelon Generation Company, LLC (Exelon, the licensee) submitted requests to the U.S. Nuclear Regulatory Commission (NRC). Exelon proposed alternatives to certain inservice inspection (ISI) requirements of the American Society of Mechanical Engineers Boiler & Pressure Vessel Code (ASME Code) for the Peach Bottom Atomic Power Station (Peach Bottom), Units 2 and 3.

2.0 REGULATORY EVALUATION

Adherence to Section XI of the ASME Code is mandated by Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g)(4), which states, in part, that ASME Code Class 1, 2, and 3 components (including supports) will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI.

Section 50.55a(z) to 10 CFR states, in part, that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if the licensee demonstrates that: (1) the proposed alternative provides an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request the use of alternatives and the NRC to authorize the proposed alternatives.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Proposed Alternative Request I5R-02

Background

Pursuant to 10 CFR 50.55a(z)(2), the licensee is requesting relief from IWE-1232 to exempt penetration N-3 (inaccessible construction manhole at bottom head of drywell) of Peach Bottom from IWE examinations because compliance would involve extensive structural modifications to the containment structure, resulting in a hardship or unusual difficulty, without a compensating increase in the level of quality and safety. Article IWE-1232 of the ASME Code requires an evaluation of the acceptability of the inaccessible areas when conditions exist in accessible areas that could indicate degradation and associated documentation.

ASME Code Component Affected

The affected components at Peach Bottom, Units 2 and 3, belong to Examination Categories E-A and E-G, specifically Item Nos. E1.11 and E8.10, related to penetration N-3.

Applicable Code Edition and Addenda

This request applies to the fifth 10-year ISI interval in which Peach Bottom adopted the 2013 Edition of the ASME Code, Section XI, as the Code of record.

Applicable Code Requirements

ASME Section XI, paragraph IWE-1232, requires an evaluation each 10-year interval of the acceptability of the inaccessible areas when conditions exist in accessible areas that could indicate degradation and associated documentation.

Licensee's Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(z)(2), the licensee stated that instead of performing the examination of penetration N-3 at Peach Bottom, Units 2 and 3, in accordance with IWE-1232, its proposed alternative is to perform integrated leak rate testing (ILRT) (Type A tests) in accordance with the Peach Bottom Appendix J Program ("Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors"), which is maintained independent of the ASME Code, Section XI, containment inservice inspection (CISI) program. The results of the most recent Type A ILRT were provided by the licensee in its April 19, 2018, letter.

Duration of Proposed Alternative

The relief is requested for the fifth 10-year interval of the ISI program (i.e., third 10-year interval of the CISI program) and remaining term of the renewed facility operating licenses (RFOLs) for Peach Bottom, Units 2 and 3. The start and end dates of the third CISI interval and RFOLs are indicated in the table below.

Peach Bottom	Third CISI Interval		Renewed Facility Operating Licenses	
	Start Date	End Date	Start Date	End Date
Unit 2	11/05/2018	11/04/2028	08/09/2013	08/08/2033
Unit 3	11/05/2018	11/04/2028	07/03/2014	07/02/2034

NRC Staff Evaluation

In Relief Request I5R-02, the licensee requested relief from the requirements of paragraph IWE 1232(a) to exempt from examination penetration N-3 located at the bottom of the drywell of Peach Bottom. The staff has reviewed and evaluated the licensee's request on the basis that compliance with the specified requirements would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

During the review of I5R-02, the NRC staff noted that penetration N-3 is a 24-inch manhole that was placed at the bottom head of the drywell during construction, and when it was no longer needed, it was seal welded, inspected, and embedded in concrete in both Units 2 and 3. The staff also noted that penetration N-3 is a bolted gasket connection that was pneumatically tested and seal welded. However, penetration N-3 does not meet the current requirement in IWE-1232(a)(2) for exemption from examination as inaccessible welded joints because it was not double-butt welded and fully radiographed prior to being covered with concrete during construction.

Based on its review of drawing 6280-S-188 provided by Attachment 2 in the licensee's letter dated August 4, 2008 (ADAMS Accession No. ML082200279), the NRC staff noted that in order to reach penetration N-3 in both Units 2 and 3, the licensee would have to either excavate several feet of concrete around the bottom head of the drywell or remove an approximate 6 feet (ft) of concrete of the drywell floor. The staff also noted that penetration N-3 is sandwiched below an approximate 6 ft of concrete that makes the drywell floor and above approximately 8 ft of concrete (4 ft of concrete that surrounds the exterior drywell structure and another 4 ft of concrete that makes the foundation structure). The staff finds that the work required to reach penetration N-3 and make the modifications needed to meet the aforementioned ASME Code requirements would involve major structural modifications of the drywell containment and exposure of construction and/or inspecting personnel to very high radiation; therefore, fulfilling ASME Code requirement IWE-1232(a)(2) is a hardship.

The applicant's proposed alternative relies on periodic ILRTs (Type A tests) of the Peach Bottom drywells. The ILRTs are performed in accordance with 10 CFR Part 50, Appendix J, regulatory requirements to verify the overall leaktightness for each of the drywells, which includes construction penetration N-3, consistent with the Peach Bottom primary containment leakage rate testing program as delineated in Peach Bottom Technical Specification 5.5.12.

Based on its review of the letter dated August 4, 2008, the NRC staff noted that a pneumatic test of the drywells was performed satisfactorily after completion of construction of the drywells and prior to seal welding, and subsequently encasing penetration N-3 of Peach Bottom drywell shells in concrete. The NRC staff noted that these tests were conducted at high pressures (i.e., at 71.3 and 74.3 pounds per square inch (psig) for drywells at Units 2 and 3, respectively) that were well above the peak calculated containment internal pressure of 49.1 psig used for the design-basis loss-of-coolant accident in the licensee's primary containment leakage rate testing

program. The staff also noted that the allowable leakage acceptance criteria of 0.2 percent air weight per day was also more stringent than the 0.375 percent air weight per day acceptance criteria used for the primary containment leakage rate testing program. Therefore, the NRC staff finds that the results of the pneumatic tests demonstrated satisfactorily the structural integrity and leaktightness of the drywell shells, including penetration N-3, prior to their seal welding and embedment in concrete. In addition, since penetration N-3 is embedded between several feet of concrete above and below it, when the drywell is pressurized under a design-basis accident condition, the internal pressure would push the concrete against the bolted and seal welded penetration N-3, as opposed to pulling away from it. Therefore, the NRC staff finds that this loading condition further contributes to the leaktightness of penetration N-3.

The NRC staff also noted in the letter dated August 4, 2008, that the results of previous Type A ILRTs were provided in response to NRC staff requests for additional information regarding the February 29, 2008, Relief Request CRR-13 (ADAMS Accession No. ML080640587). The table below provides the results of the Type A ILRT for Peach Bottom, Units 2 and 3, as docketed in the licensee's Relief Request I5R-02 and letter dated August 4, 2008.

Type A ILRT Results for Peach Bottom, Units 2 and 3

Peach Bottom	ILRT Date	ILRT Total Weight Percent Per Day (%/day)
Unit 2	March 1991	0.2135
	October 2000	0.3365
	November 2014	0.2372
Unit 3	December 1991	0.1386
	October 2005	0.2781

The staff noted that Relief Request CRR-13 was authorized by the NRC in its February 26, 2009, safety evaluation (SE) (ADAMS Accession No. ML090430052). The staff also noted that the authorized Relief Request CRR-13 is similar and is considered by the staff to be precedence for Relief Request I5R-02. As shown in the above table, the licensee has provided the staff with the results from the ILRTs (Type A tests) performed at Peach Bottom, Units 2 and 3, since March 1991. The NRC staff noted that the total leakage measured for Units 2 and 3 is below the acceptance criteria of 0.375 percent air weight per day for these tests, as noted above. Therefore, the staff finds that the results of the most recent ILRTs (Type A tests) demonstrate that the structural integrity and leaktightness of the Peach Bottom primary containments with the embedded penetration N-3 has been maintained within the acceptance criteria.

These test results also demonstrate that there is no indication of any significant leakage taking place through penetration N-3 through 27 years of operation (since 1991). The staff also finds that the 10 CFR 50, Appendix J, containment leakage rate testing program would continue to monitor and ensure the structural integrity and leaktightness of the Peach Bottom primary containment and penetration N-3.

The staff reviewed the licensee's letters dated April 13, 2015, and September 8, 2015 (ADAMS Accession Nos. ML15104A361 and ML15196A559, respectively), as well as ISI Owner's Activity Reports dated January 20, 2016, and February 7, 2018 (ADAMS Accession Nos. ML16021A089 and ML18038B075, respectively), for Unit 3, and February 9, 2017, for Unit 2 (ADAMS

Accession No. ML17039A884), which provide results of the ISI IWE examinations of the drywell shell since 2010 for Unit 2 and 2009 for Unit 3. The staff reviewed these documents to assess whether there have been any indications of degradation on the accessible and inaccessible surface areas of the drywell that could impact the structural integrity and leaktightness of the drywell of which penetration N-3 is part. Based on its review of these documents, the staff noted that there are no indications of degradation that could impact the structural integrity and leaktightness of the drywell. Therefore, the staff finds that the results of the previous ISI IWE examinations of the drywell demonstrate that the structural and leaktight integrity of the drywell with penetration N-3 is sound and adequately managed.

The staff noted that Relief Request I5R-02 is for the fifth ISI interval (third CISI) and remaining term of the RFOLs for Peach Bottom, as indicated in the above table. The staff noted that the duration of the relief request goes beyond the fifth 10-year ISI interval (third CISI interval) of Peach Bottom, which started on November 5, 2018, and ends on November 4, 2028. The staff noted that Relief Request I5R-02 seeks approximately 5 additional years, for Unit 2, and 6 additional years, for Unit 3, beyond the fifth ISI interval (third CISI interval) in order for the relief request to be applicable until the end of the RFOLs for Units 2 and 3, which expire on August 8, 2033, and July 2, 2034, respectively. Based on the results of previous ISI IWE examinations discussed above, the staff finds that there is reasonable assurance that the integrity of both containments and their respective penetration N-3 remains intact. The staff finds that, provided the requirements from which relief is requested in I5R-02 stay the same after the fifth ISI interval (third CISI) and for the remaining term of the Peach Bottom RFOLs, compliance with such requirements will continue to be a hardship, and the performance of the ILRTs will continue to provide reasonable assurance of structural integrity and leaktightness for the primary containment drywell penetration N-3.

Based on the above evaluation of I5R-02 and precedence in the NRC staff's February 26, 2009, SE authorizing Relief Request CRR-13, the staff finds that the licensee's proposed alternative of ILRTs (Type A tests) in lieu of performing IWE examination of the Peach Bottom inaccessible penetration N-3 provides reasonable assurance of structural integrity and leaktightness for the primary containment drywell penetration N-3. The staff also finds that requiring compliance with paragraph IWE-1232(a) of the ASME Code, Section XI, would result in major modifications of the drywell containment structures and unnecessary radiation exposure to licensee personnel. Therefore, the NRC staff finds that complying with the specified Code requirement for examination of inaccessible surfaces of drywell penetration N-3 at Peach Bottom would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

3.2 Licensee's Proposed Alternative Request I5R-04

Background

Pursuant to 10 CFR 50.55a(z)(1), the licensee has proposed an alternative to the requirements of the ASME Code, Section XI. Article IWB-2500-1, Examination Category B-D of the ASME Code requires a volumetric examination of all nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles each 10-year interval. For all reactor pressure vessel (RPV) nozzle-to-vessel shell welds and nozzle inner radii, ASME Code, Section XI, requires 100 percent inspection during each 10-year ISI interval. However, ASME Code Case N-702 provides an alternative that reduces the inspection of RPV nozzle-to-vessel shell welds and nozzle inner radii areas from 100 percent to 25 percent of the nozzles for each nozzle type during each 10-year interval. This Code case was conditionally approved in Regulatory Guide (RG) 1.147, Revision 18, "Inservice Inspection Code Case Acceptability, ASME Section XI,

Division 1." For application of Code Case N-702, the licensee is required to address the conditions specified in RG 1.147, Revision 18, for Code Case N-702.

The applicability of Code Case N-702 must be shown by demonstrating that the criteria in Section 5.0 of the NRC SE regarding BWRVIP-108 dated December 19, 2007 (ADAMS Accession No. ML073600374), or Section 5.0 of the NRC SE regarding BWRVIP-241, dated April 19, 2013 (ADAMS Accession No. ML13071A240), are met. The evaluation demonstrating the applicability of the Code case shall be reviewed and approved by the NRC prior to the application of the Code case.

BWRVIP-108, "Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii" (proprietary/non-public) and BWRVIP-241, "BWR [Boiling Water Reactor] Vessel and Internals Project, Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii" (ADAMS Accession No. ML11119A043), contains probabilistic fracture mechanic analysis results supporting Code Case N-702. Both reports are for 40 years of operation. BWRVIP-24 contains additional probabilistic fracture mechanic results supporting revision of the evaluation criteria under "Conditions and Limitations" in the SE for BWRVIP-108. The SE for BWRVIP-241 accepted the revised criteria.

On April 26, 2017, the NRC issued a revised final SE (ADAMS Accession No. ML17114A096) on a supplemental document for license renewal, BWRVIP-241, Appendix A, "BWR Nozzle Radii and Nozzle-to-Vessel Welds Demonstration of Compliance with the Technical Information Requirements of the License Renewal Rule (10 CFR 54.21)." This Appendix A license renewal extends the applicability of the BWRVP-108 and BWRVIP-241 methodologies, and, therefore, Code Case N-702, from 40 years to the period of extended operation.

Code Case N-702 allows that VT-1 visual examination may be performed in lieu of volumetric examination for Examination Item No. B3.100 nozzle inner radius sections. Code Case N-648-1, as conditionally accepted by RG 1.147, Revision 18, requires that nozzle inner radius examinations must use the allowable flaw length criteria of ASME Code Table IWB-3512-1, with limiting assumptions on the flaw aspect ratio.

ASME Code Component Affected

The affected components at Peach Bottom, Units 2 and 3, belong to Examination Category B-D, "Full Penetration Welded Nozzles in Vessels," under Examination Item No. B3.90, "Nozzle-to-Vessel Welds," and B3.100, "Nozzle Inside Radius Section."

Table 1

RPV Nozzle-to-Vessel Welds and Inner Radii Subject to this Request

Identification Number	Description	Total Number	Minimum Number to be examined
N2	Recirculation Inlet	10	3
N3	Main Steam	4	1
N5	Core Spray	2	1
N6	Nozzles on Top of Head	2	1
N8	Jet Pump Instrumentation	2	1

Applicable Code Edition and Addenda

This request applies to the fifth 10-year ISI interval in which Peach Bottom adopted the 2013 Edition of the ASME Code, Section XI, as the Code of record.

Applicable Code Requirements

ASME Code, Section XI, Table IWB-2500-1, Examination Category B-D, requires a volumetric examination of all nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles each 10-year interval.

Licensee's Proposed Alternative and Basis for Use

The licensee proposed to implement Code Case N-702 and reduce the ASME Code-required volumetric examinations for all RPV nozzle-to-shell welds and inner radii to a minimum of 25 percent of the nozzle inner radii and nozzle-to-shell welds, including at least one nozzle from each system and nominal pipe size during each inspection interval. The required examination volume for the reduced set of nozzles remains at 100 percent of that depicted in Figure IWB-2500-7, (a) through (d), as applicable in the ASME Code.

In addition, the licensee stated it may perform a VT-1 visual examination, as outlined in Code Case N-648-1, in lieu of a volumetric examination for Category B-D, Item No. 3.100.

The alternatives are based on the probabilistic fracture mechanic results documented in the BWRVIP-241 report. The licensee proposed that it met the evaluation criteria in the SE for BWRVIP-241, as follows:

(1) Maximum RPV Heatup/Cooldown Rate

The maximum RPV heatup/cooldown rate is limited to < 115 degrees Fahrenheit (°F)/hour.

Peach Bottom Technical Specification 3.4.9, "RCS Pressure and Temperature (PIT) Limits," Surveillance Requirement 3.4.9.1, heatup and cooldown rates are limited to a maximum of 100 °F when averaged over any 1-hour period, and thus, meet the requirement of Criterion 1.

(2) Recirculation Inlet (N2) Nozzles

$(pr/t) / C_{i\text{-}RPV} < 1.15$, where

p = RPV normal operating pressure (psi),
r = RPV inner radius (inch),
t = RPV wall thickness (inch), and
$C_{i\text{-}RPV} = 19332$.

The Peach Bottom result based on the input parameters for this nozzle per the licensee submittal is $(pr/t) / C_{i\text{-}RPV} = 1.10$ ([(1035)(125.5)/6.125]/19332), thus meeting the requirements of Criterion 2.

(3) Recirculation Inlet (N2) Nozzles

$[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{i\text{-}NOZZLE} < 1.47$, where
r_o = nozzle outer radius (inch),
r_i = nozzle inner radius (inch), and
$C_{i\text{-}NOZZLE} = 1637$.

The Peach Bottom result based on the input parameters for this nozzle per the licensee's submittal is $[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{i\text{-}NOZZLE} = 0.98$ ($[1035(12.5^2 + 5.784^2)/(12.5^2 – 5.784^2)]/1637$), thus meeting the requirements of Criterion 3.

(4) Recirculation Outlet (N1) Nozzles

$(pr/t)/C_{o\text{-}RPV} \leq 1.15$, where

r = RPV inner radius (inch),
t = RPV wall thickness (inch), and
$C_{o\text{-}RPV} = 16171$.

The Peach Bottom result based on the input parameters for this nozzle per the licensee's submittal is $(pr/t)/C_{o\text{-}RPV}$ 1.31 ($[(1035)(125.5)/6.125]/16171$), which does not meet the requirements of Criterion 4. Because Criterion 4 is not met, the licensee stated that the recirculation outlet (N1) nozzles are not included in the licensee's proposed alternatives.

(5) Recirculation Outlet (N1) Nozzles

$[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{o\text{-}NOZZLE} \leq 1.59$, where

r_o = nozzle outer radius (inch),
r_i = nozzle inner radius (inch), and
$C_{o\text{-}NOZZLE} = 1977$.

The Peach Bottom result based on the input parameters for this nozzle per the licensee's submittal is $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{o\text{-}NOZZLE} = 0.85$ ($[1035(26.5^2 + 12.97^2)/(26.5^2 – 12.97^2)]/1977$), thus meeting the requirements of Criterion 5.

The licensee addressed the requirements of BWRVIP-241, Appendix A, by describing how Section A.3, "Management of Aging Effects," and Section A.4, "Time-Limited Aging Analysis," are met to satisfy the requirements of 10 CFR 54.21, "Contents of application-technical information." With respect to irradiation effects, the licensee states that the nozzles discussed in this request are not exposed to high neutron fluence, but credits Updated Final Safety Analysis Report (UFSAR) Appendix Q.1.12, "Reactor Materials Surveillance Program," to ensure continued monitoring of vessel irradiation. With respect to fatigue management, the licensee credits UFSAR Appendix Q.4.2, "Fatigue Management Activities," to ensure that fatigue is adequately managed. The licensee also credits UFSAR Appendix Q.1.8, "Inservice Inspection (ISI) Program," and Appendix Q.2.7, "Reactor Pressure Vessel and Internals ISI Program," to identify and implement the various inspection requirements for the period of extended operation.

NRC Staff Evaluation

The licensee proposed an alternative to implement Code Case N-702 for all Peach Bottom RPV nozzle-to-vessel shell penetration welds and nozzle inner radii using the criteria in BWRVIP-241.

In general, the applicability of the BWRVIP-241 report to a Code Case N-702 alternative is demonstrated by showing that Criteria 2 through 5 within Section 5.0 of the NRC SE for BWRVIP-241 are met for the bounding nozzles (recirculation inlet and outlet nozzles), and that Criterion 1 is met for all components included in the proposed alternative.

The NRC staff confirms that Criterion 1 (applicable to all nozzles within the scope of Code Case N-702) is satisfied because Peach Bottom Technical Specification Surveillance Requirement 3.4.9.1 limits the maximum heatup/cooldown rate to less than or equal to 100 °F/hour, well below the 115 °F/hour criterion limit.

For Criteria 2 to 5, the licensee provided plant-specific data and its evaluation of the driving force factors, or ratios, using the criteria established in Section 5.0 of the BWRVIP-241 SE. The licensee showed that Criteria 2, 3, and 5 are satisfied, but that Criterion 4 is not satisfied. Because Criterion 4 is not satisfied, the licensee excluded the recirculation outlet (N1) nozzles from this proposed alternative. The NRC staff reviewed the licensee's calculations and confirms that they show that Criteria 2 and 3 are satisfied. The NRC staff notes that Criteria 4 and 5 are not relevant to this SE, since the N1 nozzles are not part of the licensee's proposed alternatives. Therefore, the BWRVIP-241 report applies to Peach Bottom (excluding the N1 nozzles), and the basis for using Code Case N-702 is demonstrated for the Peach Bottom RPV nozzle-to-vessel welds and inner radii listed in Table 1 above.

The licensee's submittal addresses the requirements of BWRVIP-241, Appendix A, by describing how the management of aging effects and a time-limited aging analysis are implemented to satisfy the requirements of 10 CFR 54.21. The licensee specifically addressed irradiation effects, fatigue, and inspection programs. The licensee states that the nozzles discussed in this request are not exposed to neutron fluence greater than 1×10^{17} n/cm^2, but that UFSAR Appendix Q.1.12 will ensure continued monitoring of vessel irradiation. The NRC staff confirms that irradiation effects should not be a concern for the nozzles in this request based on a fluence less that the 1×10^{17} n/cm^2 threshold. The NRC staff verifies that UFSAR Appendix Q.1.12 is adequate to ensure continued monitoring of vessel irradiation during the period of extended operation.

With respect to fatigue management, the licensee credits UFSAR Appendix Q.4.2 to ensure that fatigue is adequately managed. The NRC staff verified that UFSAR Appendix Q.4.2 is adequate to manage the aging effects of fatigue. The NRC staff verified that UFSAR Q.4.2 addresses the time-limited aging analyses required for the period of extended operation.

With respect to inspection activities, the licensee credits UFSAR Appendix Q.1.8 and Appendix Q.2.7 to identify and implement the various inspection requirements for the period of extended operation. The NRC staff verifies that UFSAR Appendix Q.1.8 and Appendix Q.2.7 adequately provide inspection requirements to manage the aging effects of fatigue and provide the required time-limited aging analyses for the period of extended operation.

For Examination Item No. B3.100 nozzle inner radius sections, the NRC staff finds the licensee's proposal to perform VT-1 visual examination in lieu of ultrasonic examination to be

acceptable, since the licensee will comply with Code Case N-648-1, with associated required conditions specified in RG 1.147, Revision 18. Therefore, the NRC staff finds that the proposed alternative would provide an acceptable level of quality and safety.

3.3 Licensee's Proposed Alternative Request I5R-05

Background

The licensee has proposed an alternative to the requirements of the ASME Code, Section XI, paragraphs IWA-4221 and IWA-4540(a)(2). Relief Request I5R-05 was submitted under 10 CFR 50.55a (z)(1), which covers requests for alternatives on the basis that the proposed alternative would provide an acceptable level of quality and safety.

ASME Code Components Affected

Relief Request I5R-05 covers ASME Code, Section XI, ferritic piping butt welds requiring radiography during repair/replacement activities.

Applicable Code Edition and Addenda

This request applies to the fifth 10-year ISI interval in which Peach Bottom adopted the 2013 Edition of the ASME Code, Section XI, as the Code of record.

Applicable Code Requirements

The regulation in 10 CFR 50.55a(b)(2)(xx)(B) requires:

> The NDE provision in IWA-4540(a)(2) of the 2002 Addenda of ASME Code Section XI must be applied when performing system leakage tests after repair and replacement activities performed by welding or brazing on a pressure retaining boundary using the 2003 Addenda through the latest edition and addenda incorporated by reference in paragraph (a)(1)(ii) of this section.

IWA-4540(a)(2) of the 2002 Addenda of ASME Section XI requires that the nondestructive examination method and acceptance criteria of the 1992 Edition, or later, of Section III be met prior to return to service in order to perform a system leakage test in lieu of a system hydrostatic test.

Additionally, ASME Section XI, paragraph IWA-4221, requires the owner to use the requirements of the Construction Code for repair/replacement activities. The examination requirements for ASME Section III circumferential butt welds are contained in the ASME Code, Section III, Subarticles NB-5200, NC-5200, and ND-5200. The acceptance standards for radiographic examination are specified in Subarticles NB-5300, NC-5300, and ND-5300.

ASME Code of Record

The fifth 10-year interval of the Peach Bottom, Units 2 and 3, ISI program is based on the 2013 Edition of the ASME Code, Section XI.

Licensee's Proposed Alternative and Basis for Use

The licensee is proposing the use of encoded phased array ultrasonic testing (PAUT) in lieu of the ASME Code-required radiographic testing (RT) examinations for ferritic piping repair/replacement welds. The proposed alternative qualification program is based on ASME Code Case N-831, "Ultrasonic Examination in Lieu of Radiography for Welds in Ferritic Pipe," with some small changes in wording for clarification. ASME Code Case N-831 was approved by the ASME Standards Committee on September 27, 2016.

The encoded PAUT procedures, equipment, and personnel will be qualified using performance demonstration testing. The flaw acceptance standards for the PAUT tests will consider all flaws to be planar and be evaluated against the preservice acceptance standards of ASME Section XI, IWB-3400, IWC-3400, or IWD-3400 for ASME Code Class 1, 2, or 3 welds, respectively.

The overall basis for proposed alternative I5R-05 is that encoded PAUT is equivalent or superior to RT for detecting and sizing planar flaws. In this regard, the basis for the proposed alternative was developed from numerous codes, Code cases, associated industry experience, articles, and the results of RT and encoded PAUT examinations. It has been shown that PAUT provides an equally effective examination for identifying the presence of fabrication flaws in carbon steel welds compared to RT. The examination procedure and personnel performing examinations are qualified using representative piping conditions and flaws that demonstrate the ability to detect and size flaws that are both acceptable and unacceptable to the defined acceptance standards.

Duration of Proposed Alternative

Relief is requested for the fifth ISI interval for Peach Bottom, Units 2 and 3, or until the NRC approves ASME Code Case N-831, or a later revision, in RG 1.147, or other document, during the interval. The fifth ISI interval for Peach Bottom, Units 2 and 3, is currently scheduled to begin on January 1, 2019, and end on December 31, 2028.

NRC Staff Evaluation

The licensee is proposing to use encoded PAUT in lieu of RT in ISR-05 for repair and replacement activities for the fifth 10-year ISI intervals at Peach Bottom, Units 2 and 3. Ultrasonic testing (UT), like RT, is a volumetric inspection technique that is commonly used to inspect welds in nuclear power plants and other industries. Ultrasonic inspections are not equivalent to radiographic inspections, as they use different physical mechanisms to detect and characterize discontinuities. These differences in physical mechanisms result in several key differences in sensitivity and discrimination capability.

The NRC staff has been assessing the effectiveness of the use of ultrasound in lieu of radiography since 2009, including literature reviews, detailed evaluations of previous relief requests and proposed alternatives, and confirmatory experimental work to validate the findings. An assessment of the use of UT in lieu of RT by the NRC is described in the 2015 NUREG/CR-7204, "Applying Ultrasonic Testing In Lieu of Radiography for Volumetric Examination of Carbon Steel Piping" (ADAMS Accession No. ML15253A674). This report included evaluation on the use of UT in lieu of RT for welded pipes and plates with thicknesses ranging from 0.844 inches to 2.2 inches thick.

One conclusion from NUREG/CR-7204 is:

> Considering overall detections/non-detections for the piping specimens, as well as the Navy plates, it appears that phased array ultrasonic inspection (PA-UT), based on the techniques applied in this study, provides an equally effective examination for identifying the presence of fabrication flaws in carbon steel welds. The PA-UT parameters applied were shown to be more effective for planar flaws, but slightly less effective for small volumetric flaws, than RT.

Based on this research, the NRC staff finds that there is a sufficient technical basis for the use of UT in lieu of RT for ferritic steel welds. Given that UT in lieu of RT can be effective, the NRC staff worked to determine if the proposed alternative applies UT in a way that provides reasonable assurance of finding structurally significant flaws.

Important aspects of this proposed alternative include:

- The examination volume shall include 100 percent of the weld volume and the weld-to-base-metal interface.

- The electronic data files for the PAUT examinations will be stored as archival-quality records. In addition, hard copy prints of the data will also be included as part of the PAUT examination records to allow viewing without the use of hardware or software.

- Ultrasonic examination procedures shall be qualified by using either a blind or a non-blind performance demonstration using a minimum of 30 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws. The demonstration set shall include specimens to represent the minimum and maximum diameter and thickness covered by the procedure.

- The flaw through-wall heights for the performance demonstration testing shall be based on the applicable acceptance standards for volumetric examination in accordance with IWB-3400, IWC-3400, or IWD-3400. At least 30 percent of the flaws shall be classified as acceptable planar flaws, with the smallest flaws being at least 50 percent of the maximum allowable size based on the applicable a/l aspect ratio for the flaw.

- Ultrasonic examination personnel shall demonstrate their capability to detect and size flaws by performance demonstration using the qualified procedure. The demonstration specimen set shall contain at least 10 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws.

- All flaws detected using angle-beam ultrasonic inspections will be treated as planar flaws and will be evaluated against the preservice acceptance standards of ASME Section XI, IWB-3400, IWC-3400, or IWD-3400 for ASME Code Class 1, 2, or 3 welds, respectively.

A significant change from the use of Section III radiography requirements is the use of Section XI flaw acceptance standards as opposed to Section III, NB-5330, NC-5330, and ND-5330 flaw acceptance standards. Section III acceptance standards require the inspector to detect and determine the type of flaw (e.g., porosity, lack of fusion, slag, incomplete penetration). While radiography is effective at discerning between different flaw types, it is less

capable than UT at detecting planar flaws such as cracks and lack-of-fusion defects. While ASME Section XI, IWB-3400, IWC-3400, and IWD-3400, allow larger flaws than Section III, NB-5330, NC-5330, and ND-5300, the use of ASME Section XI acceptance standards has proven effective for piping welds for ISIs. The NRC staff finds that the use of ASME Section XI acceptance standards is appropriate for the proposed alternative, as the proposed alternative is for repair/replacement activities, not new plant construction and the favorable industry experience with the ASME Code, Section XI flaw acceptance standards.

Based on the inspection and qualification requirements described in ISR-05, and the results of NUREG/CR-7204, the NRC staff finds that there is reasonable assurance that the encoded phased array UT qualified as proposed by the licensee will provide an adequate level of quality and safety.

3.4 Licensee's Proposed Alternative Request I5R-06

Background

Pursuant to 10 CFR 50.55a(z)(1), the licensee has requested an alternative to the examination requirements in Examination Category B G 1, Item No. B6.40, which is listed in Table IWB 2500 1, "Examination Categories," of the ASME Code, Section XI. This item requires volumetric examination, every ISI interval, of all the threads in RPV flange stud holes, as indicated in Figure IWB 2500 12, "Closure Stud and Threads in Flange Stud Hole," of the ASME Code, Section XI.

ASME Code Components Affected

Relief Request I5R-06 applies to the RPV threads in flange Examination Category B-G-1, Item No. B6.40, in the ASME Code, Section XI.

Examination Category	Item No.	Examination Method	Description	Code Class
B-G-1	B6.40	Volumetric	RPV Threads in Flange	1

Applicable Code Edition and Addenda

This request applies to the fifth 10-year ISI interval in which Peach Bottom adopted the 2013 Edition of the ASME Code, Section XI, as the Code of record.

Applicable Code Requirements

For the fifth 10-year ISI interval at Peach Bottom, the Code of record for the inspection of ASME Code Class 1, 2, and 3 components is the 2013 Edition of the ASME Code, Section XI. The fifth ISI interval for Peach Bottom is scheduled to begin on January 1, 2019, and is scheduled to end on December 31, 2028.

Licensee's Technical Basis for Proposed Alternative and Basis for Use

The licensee states that the technical basis for eliminating the RPV threads in flange volumetric examinations is provided in Electric Power Research Institute (EPRI) Report No. 3002007626, dated March 2016 (ADAMS Accession No. ML16221A068, hereinafter referred to as the EPRI report). The licensee discussed the potential degradation mechanisms, bounding stress

analysis, flaw tolerance evaluation, and operating experience that were included in the EPRI report and concludes that these justify the elimination of volumetric examination of RPV threads. The licensee performed a stress analysis specific to Peach Bottom and compared the plant-specific preload stress to the bounding preload stress provided in the EPRI report. The licensee found that the preload stress for Peach Bottom, Units 2 and 3 (calculated as 30,363 pounds per square inch (psi)) was bounded by the preload stress in the EPRI report (calculated as 42,338 psi). The licensee notes that the conclusion from the EPRI evaluation "is that the current requirements are not commensurate with the associated burden (worker exposure, personnel safety, radwaste, critical path time, and additional time at reduced water inventory) of the examination."

The licensee also states that the requirements in the relief request are based on ASME Code Case N-864, which has been approved by the ASME Board on Nuclear Codes and Standards. Code Case N-864 states that the examination requirements of Examination Category B-G-1, Item No. B6.40, are not required. Additionally, the licensee states that Peach Bottom uses detailed procedures for the care and visual inspection of the RPV threads in flange and studs every time the RPV head is removed.

The licensee provided a detailed description of the maintenance activities and inspections that will be performed on the RPV threads in flange and studs each time the RPV head is removed during the fifth ISI interval. The plant-specific procedures controlling these activities were identified. The licensee stated that these controlled maintenance activities provide assurance that any degradation would be detected and mitigated prior to returning the reactor to service.

NRC Staff Evaluation

The basis for proposed alternative I5R-06 is provided in the EPRI report. By letter dated January 26, 2017 (ADAMS Accession No. ML17006A109), the NRC staff authorized Southern Nuclear Operating Company, Inc. (SNC) to use a similar alternative that was based on the generic stress analysis and flaw tolerance evaluation in the EPRI report.

The NRC staff's evaluation of the EPRI report is documented in Section 3.2.1, "The EPRI's Generic Stress Analysis and Flaw Evaluation," of the SNC SE for the authorization. Section 3.2.1 of the SNC SE concludes that the generic stress analysis and flaw tolerance evaluation in the EPRI report are acceptable, and the results can be used to support eliminating the RPV threads in flange examination. It should be noted that this conclusion was drawn in the context of authorizing the elimination of the volumetric inspection for a single 10-year ISI interval.

The NRC staff confirmed that the licensee performed the stress analysis consistent with the EPRI report. The NRC staff also verified the licensee's calculation of preload stress at Peach Bottom (30,363 psi), and verified that it was bounded by the preload stress in the EPRI report (42,338 psi).

The NRC staff confirmed that the licensee performed a linear elastic fracture mechanics evaluation consistent with the ASME Code, Section XI, IWB-3600, and the EPRI report. The licensee used a maximum applied K (stress intensity factor) of 19.8 ksi$\sqrt{}$inch for the combined pressure, preload, and thermal stress, consistent with the EPRI report. The allowable K, based on the acceptance criteria in ASME Section XI, IWB-3610, for the RPV flange material is 69.6 ksi$\sqrt{}$inch. The NRC staff concludes that, since the allowable K is far greater than the

applied K for all postulated crack depths, the threads in the RPV flange are reasonably flaw tolerant at operating temperatures.

The NRC staff reviewed the licensee's description of the maintenance activities and inspections that will be performed on the RPV threads in flange and studs each time the RPV head is removed during the fifth ISI interval. These activities include cleaning and lubrication of the threads in flange. Although the licensee's procedure does not explicitly specify visual inspection of the threads in flange to detect degradation, the licensee's maintenance activities provide an opportunity, at frequent intervals, for the licensee to detect and mitigate degradation of the threads in flange during the fifth ISI interval.

The NRC staff notes that the basis for the acceptability of the proposal is Code Case N-864, which the licensee correctly identified as being approved by the ASME Code and supported by a generic fatigue analysis contained in the EPRI report. The NRC staff also notes that it cast a negative vote for Code Case N-864 at an ASME meeting, since it does not provide any defense-in-depth in the event of an alternate mode of failure. Therefore, in its review, the NRC staff concentrated on: (1) the adequacy of the generic fatigue analysis, (2) the applicability of the generic analysis to the licensee, and (3) the adequacy of the defense-in-depth measures proposed by the licensee.

In summary, the NRC staff has concluded that the stress analysis and flaw tolerance evaluation in the generic EPRI evaluation are bounding for Peach Bottom, Units 2 and 3. The NRC staff finds that the proposed alternative provides an acceptable level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff finds that the proposed alternative for I5R-04 provides a reasonable assurance of structural integrity of the subject welds and that complying with Code Cases N-702 and N-648-1 of the ASME Code, Section XI, provides an acceptable level of quality and safety. Additionally, the NRC staff concludes that the licensee's proposed alternative I5R-05 to use UT in lieu of RT using encoded PAUT provides reasonable assurance of structural integrity and leaktightness of Class 1 and 2 ferritic piping welds. Thus, UT, using the procedure described in the submittal of the subject welds, would provide an acceptable level of quality and safety. Also, the NRC staff determines that proposed alternative I5R-06 provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1).

For I5R-02, the NRC staff has reviewed the proposed alternative, and concludes that the alternative proposed by the licensee in Relief Request I5R-02 to use ILRTs (Type A tests) in lieu of compliance with the IWE-1232(a) ASME Code requirements would result in a hardship or unusual difficulty, without a compensating increase in the 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)(2). The NRC staff finds that there is reasonable assurance that the integrity of both containments and their respective penetration N-3 remains intact. The staff finds that, provided the requirements from which relief is requested in I5R-02 stay the same after the fifth ISI interval (third CISI) and for the remaining term of the Peach Bottom RFOLs, compliance with such requirements will continue to be a hardship, and the performance of the ILRTs will continue to provide reasonable assurance of structural integrity and leaktightness for the primary containment drywell penetration N-3.

Therefore, the NRC staff authorizes the use of Relief Requests I5R-02, I5R-04, I5R-05, and I5R-06 at Peach Bottom, Units 2 and 3, for the affected components. The fifth ISI interval for Peach Bottom, Units 2 and 3, is currently scheduled to begin on January 1, 2019, and end on December 31, 2028.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested and authorized by the NRC staff remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributors: S. Cuadrado
S. Cumblidge
J. Jenkins

Date: December 21, 2018

SUBJECT: PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 – ISSUANCE OF ALTERNATIVE REQUESTS RELATED TO THE FIFTH INSERVICE INSPECTION INTERVAL (EPID L-2018-LLR-0055, EPID L-2018-LLR-0057, EPID L-2018-LLR-0058, AND EPID L-2018-LLR-0059) DATED DECEMBER 21, 2018

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