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

September 1, 2020

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

SUBJECT: CLINTON POWER STATION, UNIT 1 – PROPOSED ALTERNATIVE I4R-02 TO THE REQUIREMENTS OF THE ASME CODE (EPID L-2019-LLR-0113)

Dear Mr. Hanson:

By letter dated December 16, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19350C642), as supplemented by letter dated June 22, 2020 (ADAMS Accession No. ML20174A530), Exelon Generation Company, LLC (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of an alternative to certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, requirements at Clinton Power Station (CPS), Unit 1.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use alternative I4R-02[1] on the basis that the alternative provides an acceptable level of quality and safety. Alternative I4R-02 uses the inspection requirements documented in ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds, Section XI, Division 1." For the VT-1 visual examinations allowed by ASME Code Case N-702, the licensee proposes to use ASME Code Case N-648-2, "Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles, Section XI, Division 1," with associated required conditions specified in Regulatory Guide (RG) 1.147, Revision 19, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," dated March 2020 (ADAMS Accession No. ML19128A244).

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1) for relief request I4R-02. Therefore, the NRC staff authorizes the use of the alternative request for CPS, Unit 1, for the fourth 10-year ISI interval that commenced on July 1, 2020, and is currently scheduled to end on June 30, 2030.

[1] The other requests contained in the licensee's December 16, 2019, letter have been or will be addressed by separate correspondence.

All other ASME Code, Section XI, requirements for which relief was not specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the Senior Project Manager, Joel S. Wiebe, at (301) 415-6606 or Joel.Wiebe@nrc.gov.

Sincerely,

Nancy L. Salgado

Digitally signed by Nancy L. Salgado
Date: 2020.09.01 16:17:11 -04'00'

Nancy L. Salgado, Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-461

Enclosure:
Safety Evaluation

cc: ListServ

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. I4R-02, ALTERNATIVE EXAMINATION REQUIREMENTS FOR

REACTOR PRESSURE VESSEL NOZZLE-TO-VESSEL SHELL WELDS AND NOZZLE INNER

RADII SECTION UTILIZING ASME CODE CASE N-702

CLINTON POWER STATION, UNIT 1

DOCKET NO. 50-461

1.0 INTRODUCTION

By letter dated December 16, 2019 (Agencywide Documents Access & Management System (ADAMS) Accession No. ML19350C642), as supplemented by letter dated June 22, 2020 (ADAMS ML20174A530), Exelon Generation Company, LLC (Exelon, the licensee) submitted relief request (RR) I4R-02 to the U.S. Nuclear Regulatory Commission (NRC) to request relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Table IWB-2500-1, regarding the fourth 10-year in-service inspection (ISI) program at the Clinton Power Station (CPS), Unit 1. The alternative is requested for the duration of the CPS, Unit 1, fourth 10-year ISI interval beginning on July 1, 2020, and scheduled to end on June 30, 2030. The supplemental letter dated June 22, 2020, corrected the value of the inner radius of the reactor outlet recirculation line N1 nozzle.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee proposes to use the inspection requirements documented in ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds, Section XI, Division 1." For the VT-1 visual examinations allowed by ASME Code Case N-702, the licensee proposes to use ASME Code Case N-648-2, "Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles, Section XI, Division 1," with associated required conditions specified in Regulatory Guide (RG) 1.147, Revision 19, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," dated March 2020. The regulation at 10 CFR 50.55a(z)(1) requires the licensee to demonstrate that the proposed alternative provides an acceptable level of quality and safety.

2.0 REGULATORY REQUIREMENTS

Regulation 10 CFR 50.55a(g) states, in part, that ISI of certain ASME Code Class 1, 2, and 3 systems and components be performed in accordance with Section XI of the ASME Code, except the design and access provisions and the preservice examination requirements, and applicable addenda incorporated by reference in the regulations, as a way to detect anomaly and degradation indications so that structural integrity of these components can be maintained.

Enclosure

Regulation 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for ISI of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that ISI examination of components and system pressure tests conducted during the first 10 year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b), twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

Regulation 10 CFR 50.55a(z) states, in part, that alternatives to the requirements of paragraphs (b) through (h) of 10 CFR 50.55a, or portions thereof, must be submitted and authorized by the NRC prior to implementation. The applicant or licensee must demonstrate that: (1) the proposed alternative would provide 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, and the Commission to authorize, the alternative requested by the licensee.

3.0 LICENSEE'S EVALUATION

3.1 Background

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, which 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 ASME Code Case was conditionally approved in RG 1.147, Revision 19. For application of ASME Code Case N-702, the licensee is required to address the conditions specified in RG 1.147, Revision 19 (ADAMS Accession No. ML19128A244 N-), for ASME Code Case 702, as follows:

> The applicability of Code Case N-702 must be shown by demonstrating that the criteria in Section 5.0 of NRC Safety Evaluation (SE) regarding BWRVIP-108, "BWR Vessel Internals Project: Technical Basis for Reduction of Inspection Requirements for Boiling Water Reactor Nozzle-to-Vessel Shell Welds, and Nozzle Blend Radii," dated December 19, 2007 (ADAMS Accession No. ML073600374) or Section 5.0 of NRC SE regarding BWRVIP-241, "BWR Vessel Internals Project: Probabilistic Fracture Mechanics (PFM) Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii," 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.

The BWRVIP-108, (ADAMS Accession Nos. ML023360232 and ML023360234; non-publicly available) and BWRVIP-241, (ADAMS Accession Nos. ML11119A042, non-publicly available, and ML11119A043, publicly available) contain PFM analysis results supporting Code Case N-702. Both reports are valid for 40 years of operation.

3.2 ASME Code Component Affected

The affected components (Table 1) belong to Examination Category B-D, “Full Penetration Welded Nozzles in Vessels,” under Examination Item Number 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. Note: Third ISI interval examinations revealed no rejectable indications
N1	20-inch Recirculation Outlet Nozzles	2	1
N2	10-inch Recirculation Inlet Nozzles	10	3
N3	24-inch Main Steam Nozzles	4	1
N5	12-inch Core Spray Nozzles	2	1
N6	10-inch Low Pressure Coolant Injection Nozzles	3	1
N7 and N8	6-inch Head Spray Nozzles	2	1
N9	4-inch Jet Pump Instrumentation Nozzles	2	1
N16	Vibration Instrumentation Nozzle	1	1

3.3 Applicable Code Edition and Addenda

The fourth 10-year ISI interval of CPS, Unit 1, is based on the ASME Code, Section XI, 2013 Edition. Additionally, for ultrasonic examinations, ASME Code, Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," of the 2013 Edition is implemented as required (and modified) by 10 CFR 50.55a(b)(2)(xiv) and (xviii).

3.4 Applicable Code Requirements

The applicable requirement is contained in Subsection IWB, Table IWB-2500-1, "Examination Category B-D, Full Penetration Welded Nozzle in Vessels - Inspection Program," Class 1 Reactor Vessel nozzle-to-vessel shell weld and nozzle inner radii examination requirements are delineated in Item Nos. B3.90, "Nozzle-to-Vessel Welds," and B3.100, "Nozzle Inside Radius Section." The required method of examination is volumetric examinations of all nozzles with full

penetration welds to the vessel shell (or head) and integrally cast nozzles are examined each interval. All the nozzles listed in Section 3.2 of this SE are full penetration welds.

3.5 Licensee's Proposed Alternative

NRC Regulatory Guide (RG) 1.147, Revision 19, conditionally accepts the use of ASME Code Case N-702. This code case provides an alternative to performing examination of 100 percent of the nozzle-to-vessel welds and inner radii for Examination Category B-D nozzles with the exception of the feedwater and control rod drive return line (CRDRL) nozzles. The alternative is to perform examination of 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, excluding the Feedwater and CRDRL nozzles.

3.6 Licensee's Basis for Alternative

The alternative is based on the PFM results documented in the BWRVIP-241 report. In its letter dated December 19, 2019, and as supplemented by letter dated June 22, 2020, the licensee states that it meets the evaluation criteria in the SE for BWRVIP-241 as follows:

Criterion 1 Max RPV Heat-up/Cooldown Rate

This criterion is met by adherence to CPS, Unit 1, Technical Specification (TS) 3.4.11, "Reactor Coolant System Pressure/Temperature Limits," Surveillance Requirement 3.4.11.1 which requires verification that the Reactor Coolant System (RCS) heat-up and cooldown rates are limited to less than or equal to 100°F in any one hour period and, less than or equal to 20°F in any one hour period during RPV pressure testing.

Criterion 2 Reactor Recirculation Inlet (N2) Nozzles

$(pr/t)/C_{RPV} \leq 1.15$;
p=RPV Normal Operating Pressure 1025 psig
r=RPV inner radius 110.19 inches
t=RPV wall thickness 6.1 inches
C_{RPV}= 19332
Result: (pr/t)/CRPV = 0.96 ≤ 1.15

The calculation for the CPS N2 Nozzle results in a maximum value of 0.96, which is less than 1.15 and satisfies this criterion.

Criterion 3 Recirculation Inlet (N2) Nozzles

$[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} \leq 1.15$;
p=RPV Normal Operating Pressure 1025 psig
r_o=nozzle outer radius 11.69 inches
r_i=nozzle inner radius 5.81 inches
C_{NOZZLE} 1637
Result: $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} = 1.04 \leq 1.15$

The calculation for the CPS N2 Nozzle results in a maximum value of 1.04, which is less than 1.15 and satisfies this criterion.

Criterion 4 <u>Reactor Recirculation Outlet Nozzles (N1)</u>

$(pr/t)/C_{RPV} \leq 1.15$;
p=RPV $_{\text{Normal Operating Pressure}}$ 1025 psig
r=RPV $_{\text{inner radius}}$ 110.19 inches
t=RPV $_{\text{wall thickness}}$ 6.1 inches
C_{RPV}= 16171
Result: $(pr/t)/C_{RPV} = 1.14 \leq 1.15$

The calculation for the CPS, Unit 1, N1 Nozzle results in a value of 1.14, which is less than 1.15 and satisfies the criterion.

Criterion 5 <u>Recirculation Outlet (N1) Nozzles</u>

$[p(r_o^2+r_i^2)/(r_o^2-r_i^2]/C_{NOZZLE} \leq 1.15$;
p=RPV $_{\text{Normal Operating Pressure}}$ 1025 psig
r_o=$_{\text{nozzle outer radius}}$ 16.3125 inches
r_i=$_{\text{nozzle inner radius}}$ 9.0 inches
C_{NOZZLE} 1977
Result: $[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{NOZZLE} = 0.97 \leq 1.15$

The calculation for the CPS N1 Nozzle results in a value of 0.97, which is less than 1.15 and satisfies the criterion.

The licensee further stated that the analyses in BWRVIP-108 and BWRVIP-241 were based on predicted fatigue crack growth over the initial licensed operating period and assumed additional fatigue cycles in evaluating fatigue crack growth.

The proposed alternative provides an acceptable level of quality and safety based on the technical content of BWRVIP-108 and BWRVIP-241, as endorsed by the NRC SEs, and the reduction in examination scope could provide a dose savings of as much as 25 rem [Roentgen equivalent man] for the entire fourth ISI Interval.

The licensee evaluated the probability of failure (PoF) values for low temperature overpressure (LTOP) event using the staff approved BWRVIP-108, report. Based on the evaluation, the licensee concluded that for CPS, Unit 1, the PoF value at nozzle inner radii and at nozzle-to shell welds during LTOP event is less than $1x10^{-6}$ for 40 years of operation. This value is valid with or without inspections of the nozzles addressed in BWRVIP-108 report. Therefore, the report justifies the inspection of 25 percent area of the nozzle inner radii area based on the low PoF value. The licensee stated that it will continue to perform volumetric examinations for the nozzle inner radii areas.

Furthermore, the licensee stated that the analyses for the nozzles in BWRVIP-108 and BWRVIP-241 are based on the assumptions that neutron fluence value at all the nozzles is negligible because the analysis for the initial 40 years of plant operation indicated that the peak fluence at CPS, Unit 1, is expected to be less than the threshold limit criteria of irradiation embrittlement, i.e.,$1.0\ x10^{17}$ n/cm^2 (E>1MeV).

4.0 NRC STAFF EVALUATION

The NRC staff reviewed the information in RR I4R-02, including the supplemental information in the letter dated June 22, 2020. The NRC staff reviewed the status of the referenced BWRVIP reports and found application of the referenced BWRVIP reports to be acceptable, provided that the NRC conditions associated with the latest staff's SE for each BWRVIP report are implemented.

The licensee proposed an alternative to implement ASME Code Case N-702 for CPS, Unit 1, RPV nozzle-to-vessel shell penetration welds and nozzle inner radii using the criteria in BWRVIP-241. The applicability of the BWRVIP-241 report to an ASME 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, and that Criterion 1 is met for all components included in the proposed alternative.

The NRC staff confirms that Criterion 1 is satisfied because CPS, Unit 1, Technical Specification Surveillance Requirement 3.4.11.1 limits the maximum heat-up/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 staff's safety evaluation (SE) for BWRVIP-241 report. The NRC staff reviewed the licensee's calculations and confirms that they show that Criteria 2 to 5 are satisfied. Therefore, the BWRVIP-241 report is applicable, and the basis for using ASME Code Case N-702 is demonstrated for the CPS, Unit 1, in Section 3.6 of this SE.

For CPS, Unit 1, the PoF value at nozzle inner radii and at nozzle-to shell welds during LTOP event is less than $1x10^{-6}$ for 40 years of operation. This value is valid with or without inspections of the nozzles addressed in BWRVIP-108 report. Therefore, the report justifies the inspection of 25 percent area of the nozzle inner radii area based on the low PoF value. The licensee stated that it will continue to perform volumetric examinations for the nozzle inner radii areas.

This alternative is requested for the duration of the fourth 10-year ISI interval at CPS, Unit 1, and that the ASME Code Case N-702 examination requirements shall be met during this entire timeframe. Specifically, a minimum of 25 percent of nozzle inner radii and nozzle-to-shell welds, including at least one nozzle from each system and nominal pipe size, as identified in RR I4R-02, will be examined during each 120-month ISI inspection interval in accordance with the conditions for the implementation of ASME Code Case N-702. These conditions are defined in RG 1.147, Revision 19. The licensee shall adhere to these requirements during the fourth 10-year ISI fourth interval at CPS, Unit 1. The staff noted that during the third ISI interval examinations of the nozzles addressed in the afore-mentioned Table 1 of this SE, revealed no rejectable indications. This observation provides reasonable assurance that there is no active aging degradation in the subject nozzles addressed in Table 1 of this SE.

Consistent with the requirements addressed in BWRVIP-241 and BWRVIP-108 reports, the licensee stated that all the nozzles addressed in these reports are not exposed to a neutron fluence value greater than $1.0 \times E^{17}$ n/cm^2 (E>1MeV) during the fourth ISI interval. Therefore, the NRC staff concluded that in the absence of any potential irradiation embrittlement on these nozzles, the bases for examining a limited area of these nozzles are valid during the fourth 10-year ISI interval at CPS, Unit 1.

5.0 CONCLUSION

As set forth above, the NRC staff determines that for RR I4R-02, the proposed alternative provides an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1) for RR I4R-02. Therefore, the NRC staff authorizes the use of the alternative request for CPS, Unit 1, for the fourth 10-year ISI interval.

The NRC staff notes that if the licensee intends to take exceptions to, or deviations from, the staff approved BWRVIP inspection guidelines, which will require the licensee to revise and resubmit this relief request. The licensee shall obtain NRC staff approval for such exceptions prior to implementing the revised inspection guidelines for CPS, Unit 1, pursuant to 10 CFR 50.55a(z).

All other requirements of the ASME Code, Section XI, for which an alternative has not been specifically requested remain applicable, including third-party review by the Authorized Nuclear In-service Inspector. Any ASME Code, Section XI, reactor vessel internals components that are not included in this relief request will continue to be inspected in accordance with the ASME Code, Section XI requirements.

Principal Contributor: G. Cheruvenki.

Date: September 1, 2020

SUBJECT: CLINTON POWER STATION, UNIT 1 – PROPOSED ALTERNATIVE I4R-02 TO THE REQUIREMENTS OF THE ASME CODE (EPID L-2019-LLR-0113) DATED SEPTEMBER 1, 2020

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