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

December 5, 2017

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: NINE MILE POINT NUCLEAR STATION, UNITS 1 AND 2 – ALTERNATIVE TO THE REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE (CAC NOS. MF9381 AND MF9382; EPID L-2017-LLR-0015)

Dear Mr. Hanson:

By letter dated March 7, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17067A056), as supplemented by letters dated July 24, 2017, and September 18, 2017 (ADAMS Accession Nos. ML17206A101 and ML17261A051, respectively), Exelon Generation Company, LLC (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for use of an alternative to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PV Code), Section XI requirements at Nine Mile Point Nuclear Station (Nine Mile Point), Units 1 and 2.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 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.

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 and applies to all requested Nine Mile Point, Unit 1 and 2, reactor pressure vessel nozzles. However, this relief request does not include feedwater nozzles and control rod drive return nozzles. 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).

Therefore, the NRC staff authorizes the licensee's proposed alternative to use 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 inspection of nozzle-to-vessel shell welds and nozzle inner radii sections of reactor pressure vessel nozzles listed in Section 3.1 of the enclosed safety evaluation for the remainder of the current 10-year intervals (fourth inservice inspection (ISI) interval for Unit 1 and third ISI interval for Unit 2), as well as each 10-year ISI interval during the remaining terms of the Nine Mile Point, Units 1 and 2, Renewed Facility Operating Licenses, which currently expire on August 22, 2029, and October 31, 2046, respectively.

All other ASME B&PV 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 Nine Mile Point project manager, Michael Marshall, at (301) 415-2871 or Michael.Marshall@nrc.gov.

Sincerely,

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

Docket Nos. 50-220 and 50-410

Enclosure:
Safety Evaluation

cc w/Enclosure: Distribution via Listserv

UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO RELIEF REQUEST NMP-RR-001

NINE MILE POINT NUCLEAR STATION, LLC

EXELON GENERATION COMPANY, LLC

NINE MILE POINT NUCLEAR STATION, UNITS 1 AND 2

DOCKET NOS. 50-220 AND 50-410

1.0 INTRODUCTION

By letter dated March 7, 2017, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17067A056)), as supplemented by letters dated July 24, 2017, and September 18, 2017 (ADAMS Accession Nos. ML17206A101 and ML17261A051, respectively), Exelon Generation Company, LLC (the licensee), submitted Relief Request NMP-RR-001 for the remainder of the current 10-year intervals (fourth inservice inspection (ISI) interval for Nine Mile Point Nuclear Station, Unit 1 (Nine Mile Point 1), and third ISI interval for Nine Mile Point, Unit 2 (Nine Mile Point 2)), and the remaining terms of the Nine Mile Point 1 and 2 Renewed Facility Operating Licenses. The Nine Mile Point 1 and 2 Renewed Facility Operating Licenses currently expire on August 22, 2029, and October 31, 2046, respectively.

The licensee proposed an alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PV Code) for examination requirements associated with Class 1 nozzle-to-vessel weld and nozzle inner radii as delineated in Item Number B3.90, "Nozzle-to-Vessel Welds," and B3.100, "Nozzle Inside Radius Section," of Table IWB-2500-1, "Examination Category B-D, Full Penetration Welded Nozzles in Vessels - Inspection Program B." Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), the licensee requested to use the proposed alternative 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," on the basis that the alternative provides an acceptable level of quality and safety.

2.0 REGULATORY REQUIREMENTS

ISI of the ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as a way to detect anomaly and degradation indications so that structural integrity of these components can be maintained. This is required by 10 CFR 50.55a(g), except where specific relief has been granted by the U.S. Nuclear Regulatory Commission (NRC or the Commission) pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(z) of 10 CFR states that alternatives to the requirements of paragraphs (b)

through (h) of 10 CFR 50.55a, or portions thereof, may be used when authorized by the Director, Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and authorized 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 of this section would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

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, 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 1.147, Revision 17, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," dated August 2014 (ADAMS Accession No. ML13339A689). For application of ASME Code Case N-702, the licensee is required to address the conditions specified in Regulatory Guide 1.147, Revision 17, for ASME Code Case N-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 regarding BWRVIP-108 dated December 19, 2007 (ML073600374) or Section 5.0 of NRC Safety Evaluation regarding BWRVIP-241 dated April 19, 2013 (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.

Boiling Water Reactor Vessel and Internals Project (BWRVIP)-108, "Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii" (Parts 1 and 2, ADAMS Accession Nos. ML023360232 and ML023360234, respectively (non-publicly available)), and BWRVIP-241, "Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii" (ADAMS Accession No. ML11119A043), contain probabilistic fracture mechanics (PFM) analysis results supporting Code Case N-702. Both reports are for 40 years of operation. BWRVIP-241 contains additional PFM results supporting revision of the evaluation criteria under "Conditions and Limitations" in the safety evaluation (SE) for BWRVIP-108. By letter dated December 19, 2007 (ADAMS Accession No. ML073600374), the NRC staff found that BWRVIP-108 is an efficient and effective way of addressing the issues regarding ASME Code Case N-702. By letter dated April 19, 2013 (ADAMS Package Accession No. ML13071A245), the NRC staff found that BWRVIP-241 (including the revised criteria) is acceptable for referencing, subject to the limitations specified in BWRVIP-241 and the associated NRC SE.

By letter dated October 10, 2012 (ADAMS Accession No. ML12290A017), BWRVIP submitted for NRC staff review a supplemental document for license renewal, 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 license renewal Appendix A extends the applicability of the BWRVP-108 and BWRVIP-241 methodologies (and therefore, ASME Code Case N-702), from 40 years to the period of extended operation. By letters dated March 24, 2017, and April 26, 2017 (ADAMS Accession Nos. ML17003A014 and ML17114A096, respectively), the NRC staff found that Appendix A to BWRVIP-241-A is acceptable for referencing in licensing applications for nuclear power plants to the extent specified and under the limitations delineated in the topical report and in the associated SEs.

3.0 EVALUATION

3.1 The Licensee's Request for Alternative

Components for Which Alternative is Requested (ASME Code Class 1)

- Reactor Pressure Vessel Nozzles, Unit 1: N1, N2, N3, N5, N6, and N7
- Reactor Pressure Vessel Nozzles, Unit 2: N1, N2, N3, N6, and N9

Examination Category

- B-D, "Full Penetration Welded Nozzles in Vessels" (Inspection Program B)

Examination Item Number

- B3.90, "Nozzle-to-Vessel Welds"
- B3.100, "Nozzle Inside Radius Section"

Applicable Code Edition and Addenda

The fourth 10-year ISI program at Nine Mile Point 1 is based on the ASME B&PV Code, Section XI, 2004 Edition. Additionally, for ultrasonic examinations, ASME Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," of the 2001 Edition is implemented as required and modified by 10 CFR 50.55a(b)(2)(xv).

The third 10-year ISI program at Nine Mile Point 2 is based on the ASME B&PV Code, Section XI, 2004 Edition. Additionally, for ultrasonic examinations, ASME Section XI, Appendix VIII of the 2001 Edition is implemented as required and modified by 10 CFR 50.55a(b)(2)(xv).

ASME Code Requirement for which Alternative is Requested

The applicable requirements are contained in Table IWB-2500-1, "Examination Category B-D, Full Penetration Welded Nozzles in Vessels - Inspection Program B." Class 1 nozzle-to-vessel weld and nozzle inner radii examination requirements are delineated in Item Number B3.90, "Nozzle-to-Vessel Welds," and B3.100, "Nozzle Inside Radius Section." The required method of examination is volumetric. All nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles are examined each interval.

Licensee's Proposed Alternative to the ASME Code

In accordance with 10 CFR 50.55a(z)(1), relief is requested from performing the required examinations on 100 percent of the nozzle assemblies identified in the licensee's submittal. As an alternative, for all welds and inner radii as identified in the submittal, the licensee proposed to examine a minimum of 25 percent of the nozzle-to-vessel welds and inner radii sections, including at least one nozzle from each system and nominal pipe size in accordance with Code Case N-702 for the remaining terms of the Nine Mile Point 1 and 2 Renewed Facility Operating Licenses.

Code Case N-702 stipulates that a VT-1 examination may be used in lieu of the volumetric examination for the inner radii (i.e., Item No. B3.100, "Nozzle Inside Radius Section"). The licensee explained that this VT-1 examination is outlined in Code Case N-648-1, "Alternative Requirements for Inner Radius Examinations of Class 1 Reactor Vessel Nozzles, Section XI, Division 1." The licensee stated that it will perform either volumetric examination or VT-1 examination of the inner radius as required by Code Case N-702.

Licensee's Basis for Proposed Alternative

BWRVIP-108 provides the basis for Code Case N-702. This evaluation found that failure probabilities at the nozzle blend radius region and nozzle-to-vessel shell weld due to a low temperature overpressure event are very low (i.e., $< 1 \times 10^{-6}$ for 40 years) with or without ISI. The report concluded that inspection of 25 percent of each nozzle type is technically justified.

In Section 5.0, "Conditions and Limitations," of the SE attached to the letter dated April 19, 2013, the NRC staff stated that each licensee who plans to request relief from the ASME Code, Section XI requirements for RPV nozzle-to-vessel shell welds and nozzle inner radius sections may reference BWRVIP-241 as the technical basis for the use of Code Case N-702 as an alternative. However, each licensee should demonstrate the plant-specific applicability of the BWRVIP-241 report to its units in the relief request.

Attachment 2 of the licensee's submittal provides the demonstration for the plant-specific applicability of the BWRVIP-241 report. Attachment 3 of the submittal provides the licensee's demonstration that the probability of failure (PoF) meets the BWRVIP-108 acceptance criteria through the 60-year term. Attachment 4 of the submittal evaluates the effects of the Nine Mile Point 2 safety relief valve (SRV) blowdown transient on the PoF and demonstrates that the effects of the SRV blowdown transient result in a PoF that remains acceptable through the 60-year operating term.

3.2 NRC Staff Evaluation

3.2.1 BWRVIP-108, BWRVIP-241, and NRC Requirements

The NRC staff's SE for the BWRVIP-241 report specified plant-specific criteria that must be met for applicants proposing to use this alternative in Code Case N-702.

The BWRVIP-241 NRC SE, Section 5.0, "Conditions and Limitations," states that each licensee who plans to request relief from ASME Code, Section XI requirements for RPV nozzle-to-vessel shell welds and nozzle inner radii sections may reference the BWRVIP-241 report as the technical basis for the use of Code Case N-702 as an alternative. However, each licensee should demonstrate the plant-specific applicability of the BWRVIP-241 report to its plant in the relief request by demonstrating that the general and nozzle-specific criteria are satisfied.

BWRVIP-241 documents additional PFM results supporting revision of the five evaluation criteria in BWRVIP-108. Since the objective of BWRVIP-241 is limited (i.e., revision of the limitations and conditions specified in the SE for the BWRVIP-108 report), it is considered as a supplement to BWRVIP-108 and not a replacement. The conditions and limitations specified in the SE for BWRVIP-241 supersede those in the SE for BWRVIP-108. Applicants requesting relief from the ASME Code, Section XI inspection requirements on the subject RPV nozzles for their plants must demonstrate that the five plant-specific criteria are satisfied so that BWRVIP-241 report results apply to their plants.

In the NRC staff's SE for BWRVIP-108, it was established that only the recirculation inlet and outlet nozzles need to be assessed since the conditional PoFs for other nozzles are an order of magnitude lower. It was also established that only the driving force needs to be assessed since the nozzle material fracture toughness-related RT_{NDT} values used in the PFM analyses were based on data from the entire fleet of BWR RPVs, making the PFM analyses bounding with respect to fracture resistance.

Based on the above, BWRVIP-241 documents additional PFM analyses on the recirculation inlet and outlet nozzles having the highest driving force among the BWR fleet to demonstrate that the associated vessel failure probability for the normal operation is still consistent with the NRC's safety goal, thus supporting the proposed revision of the five evaluation criteria. The NRC staff's SE for BWRVIP-241 accepted the proposed revision of the five evaluation criteria in BWRVIP-108.

3.2.2 NRC Staff's Evaluation of the Licensee's Submissions

3.2.2.1 Nine Mile Point 1

The licensee provided in its submittal dated March 7, 2017, its evaluation of the five criteria, including the driving force factors, or ratios, using plant-specific RPV and nozzle data and compared them against the criteria established in the BWRVIP-241 SE dated April 19, 2013, for Nine Mile Point 1. The staff's review and evaluation of each criterion is document below:

Criterion 1

The licensee confirmed that the maximum RPV heatup/cooldown rate is limited to less than 100 degrees Fahrenheit per hour (°F/hour) as defined in the Pressure and Temperature Limits Report referenced by Technical Specification 3.2.1 for Nine Mile Point 1. Thus, Criterion 1 established in the BWRVIP-241 SE, which limits the maximum RPV heatup/cooldown rate to less than 115 °F/hour, is satisfied for Nine Mile Point 1.

Criteria 2, 4, and 5

The calculation of Criterion 2 for the Nine Mile Point 1 N2 nozzle results in a maximum value of 0.69; thus, the staff finds Criterion 2 (1.15) established in the BWRVIP-241 SE satisfied for Nine Mile Point 1.

The calculation of Criteria 4 and 5 for the Nine Mile Point 1 N1 nozzle results in a maximum value of 0.95 and 0.93, respectively; thus, the staff finds Criterion 4 (1.15) and Criterion 5 (1.59) established in the BWRVIP-241 SE satisfied for Nine Mile Point 1.

As previously noted, the analyses that support BWRVIP-108 and BWRVIP-241 are only applicable for the original 40-year license. However, the licensee's PFM analyses for Unit 1 were only applicable to the recirculation inlet nozzle for 60 years. It is necessary for the licensee to address the Unit 1 recirculation outlet nozzle for 60 years in order to extend the application of ASME Code Case N-702 through the period of extended operation for Nine Mile Point 1.

By letter dated September 18, 2017, the licensee confirmed that the PFM analyses performed for the Nine Mile Point 1 N2 nozzle bounds the Nine Mile Point 1 N1 nozzle and the other applicable nozzles defined in its submittal for the application of ASME Code Case N-702

through the period of extended operation. As discussed below, the licensee's PFM analyses for the Nine Mile Point N2 nozzle address plant-specific nozzle geometry, elevated fluence levels, and increased thermal transient cycles at the end of 60 years of operation. Based on the licensee's confirmation that the PFM analyses performed for the Nine Mile Point 1 N2 nozzle bounds the other applicable nozzles identified in its submittal, the staff finds the licensee's response acceptable. The staff's review of the licensee's PFM analyses for the Nine Mile Point N2 nozzle is documented below.

Criterion 3

The calculation of Criterion 3 for the Nine Mile Point 1 N2 nozzle results in a maximum value of 5.927; thus, the staff finds Criterion 3 (1.47) established in the BWRVIP-241 SE is not satisfied for Nine Mile Point 1. The licensee explained that although the Nine Mile Point 1 recirculation inlet nozzle (N2) does not meet the general nozzle-specific Criterion 3 in BWRVIP-241, this specific nozzle location was addressed by BWRVIP-241. Section 5.5 of BWRVIP-241 indicates that no failures occurred in any of the simulations for the Nine Mile Point 1 N2 nozzle. BWRVIP-241 explained that the stresses in Nine Mile Point 1, in general, are lower than the other nozzles due to their location in the bottom head (i.e., the stress due to internal pressure in a sphere (i.e., bottom head) is lower than the stress due to internal pressure in a cylinder). Furthermore, the staff noted Section 6 of BWRVIP-241 indicates that BWR/2 inlet nozzles (e.g., Nine Mile Point 1 N2 nozzle) are exempt from the revised acceptance criteria based on the analysis documented in the BWRVIP report.

The licensee indicated that for extended operation to 60 years, the additional fluence and thermal cycle counts should be addressed for continued applicability of Code Case N-702. The licensee explained that the fluence at the N2 nozzle is less than 1×10^{17} neutrons per square centimeter (n/cm^2) at 46 effective full power years (EFPY) (i.e., 60 years of reactor operation) due to the nozzle location away from the beltline. Due to the expected neutron fluence for the N2 nozzle at 46 EFPY, the staff finds it acceptable that the effects of neutron fluence are assumed negligible, which is consistent with BWRVIP-108 and BWRVIP-241, and do not affect the PoF results of BWRVIP-241 for the period of extended operation.

The licensee explained that thermal fatigue crack growth (FCG) due to extended operation to 60 years is not a controlling factor. However, the staff noted that FCG and the number of thermal transients were an input into the PFM analyses performed in support of BWRVIP-108 and BWRVIP-241. By letter dated July 24, 2017, the licensee stated the determination that FCG is not a controlling factor for the PoF of the Nine Mile Point 1 N2 nozzle was based on an assessment performed to determine the amount of FCG and impact of additional thermal cycles due to license renewal operation. The licensee further explained that this assessment used the ASME Section XI, Appendix A crack growth laws and determined that the resulting crack growth was 0.24 inches for an assumed 300 cycles over 40 years, whereas the stress corrosion cracking over 40 years was determined to be 33.88 inches. As further confirmation that FCG is not a controlling factor for Nine Mile Point 1, a plant-specific evaluation was performed where the BWRVIP-241 analysis on the Nine Mile Point 1 N2 nozzle was repeated with double the number of thermal fatigue cycles used by BWRVIP-241 and still resulted in no failures over one million simulations (the same result reported in BWRVIP-241). The staff finds the licensee's response acceptable and that FCG is not a controlling factor for the PoF of the Nine Mile Point 1 N2 nozzle because the licensee demonstrated that FCG is several orders of magnitude less than the dominant mechanism (i.e., stress corrosion cracking). Furthermore, the staff finds the licensee's response acceptable because it was confirmed by a plant-specific evaluation that

double the number of thermal fatigue cycles did not alter the conclusions on the PoF for the Nine Mile Point 1 N2 nozzle in BWRVIP-241.

Criterion 3 for the recirculation inlet nozzle (i.e., N2 nozzle) was not met. However, the Nine Mile Point 1 N2 nozzle was specifically analyzed in BWRVIP-241, and it was demonstrated that no failures occurred in any of the simulations. With regard to the period of extended operation, the licensee demonstrated that fluence at the N2 nozzle is negligible at 46 EFPY (i.e., less than 1×10^{17} n/cm^2) due to the nozzle location away from the beltline, and it assessed the transient cycles applicable for 60 years of operation.

Based on the licensee's evaluation of the N1 nozzle compared to Criteria 4 and 5 of BWRVIP-241, and its plant-specific evaluation of the N2 nozzle, the NRC staff determined that the reduced inspection requirements in Code Case N-702 apply to all proposed Nine Mile Point 1 RPV nozzles through the period of extended operation. The proposed alternative also provides an acceptable level of quality and safety because the plant-specific PFM results meet the NRC safety goal on PoF through the period of extended operation.

3.2.2.2 Nine Mile Point 2

The licensee provided in its submittal dated March 7, 2017, its evaluation of the five criteria, including the driving force factors, or ratios, using plant-specific RPV and nozzle data and compared them against the criteria established in the BWRVIP-241 SE dated April 19, 2013, for Nine Mile Point 2. The staff's review and evaluation of each criterion are document below:

Criterion 1

The licensee confirmed that the maximum RPV heatup/cooldown rate is limited to less than 100 °F/hour as defined in the Pressure Temperature Limits Report (PTLR) referenced by Technical Specification 3.4.11 for Nine Mile Point 2. Thus, Criterion 1 established in the BWRVIP-241 SE, which limits the maximum RPV heatup/cooldown rate to less than 115 °F/hour, is satisfied for Nine Mile Point 2.

Criteria 2, 3, and 5

The calculation of Criteria 2 and 3 for the Nine Mile Point 2 N2 nozzle results in a maximum value of 1.03 and 0.94, respectively; thus, the staff finds Criterion 2 (1.15) and Criterion 3 (1.47) established in the BWRVIP-241 SE satisfied for Nine Mile Point 2.

The calculation of Criterion 5 for the Nine Mile Point 2 N1 nozzle results in a maximum value of 0.96; thus, the staff finds that Criterion 5 (1.59) established in the BWRVIP-241 SE satisfied for Nine Mile Point 2.

As previously noted, the analyses that support BWRVIP-108 and BWRVIP-241 are only applicable for the original 40-year license. The licensee's PFM analyses for Unit 1 were only applicable to the recirculation outlet nozzle for 60 years. It is necessary for the licensee to address the Unit 2 recirculation inlet nozzle for 60 years in order to extend the application of ASME Code Case N-702 through the period of extended operation for Nine Mile Point 2.

By letter dated September 18, 2017, the licensee confirmed that the comparative evaluation and PFM analyses associated with the Nine Mile Point 2 N1 nozzle bound the Nine Mile Point 2 N2 nozzle and the other applicable nozzles defined in its submittal for the application of ASME

Code Case N-702 through the period of extended operation. As discussed below, the licensee's comparative evaluation and PFM analyses associated with the Nine Mile Point N2 nozzle address plant-specific nozzle configurations/dimensions, material chemistry, elevated fluence levels, and increased thermal transient cycles at the end of 60 years of operation. Based on the licensee's confirmation that the comparative evaluation and PFM analyses associated with the Nine Mile Point 2 N1 nozzle bound the other applicable nozzles identified in its submittal, the staff finds the licensee's response acceptable. The staff's review of the licensee's PFM analyses for the Nine Mile Point N1 nozzle is documented below.

Criterion 4

The calculation for the Nine Mile Point 2 N1 nozzle results in a maximum value of 1.22; thus, the staff finds Criterion 4 (1.15) established in the BWRVIP-241 SE is not satisfied for Nine Mile Point 2. Consistent with Section 6 of BWRVIP-241, for plants having recirculation outlet nozzles with Criterion 4 greater than 1.15, a plant-specific analysis following the approach described in BWRVIP-241 may be able to justify values greater than 1.15. Instead of performing a plant-specific analysis, the licensee performed a comparative evaluation to a similar plant (i.e., Plant A), which performed a PFM analysis with acceptable results, to demonstrate that this analysis is bounding for Nine Mile Point 2. The relevant parameters assessed by the licensee in Attachment 3 of its submittal were nozzle configurations and dimensions, base metal and weld chemistry, fluence, and thermal transients. The staff's review of each parameter is documented below.

Nozzle Configurations and Dimensions

The licensee explained that based on a comparison of dimensions for the Nine Mile Point 2 N1 nozzle and N1 nozzle from Plant A, there is a difference between the RPV radius, vessel wall thickness, N1 nozzle bore diameter, and N1 nozzle inside radius of less than 0.5 percent. The only significant difference in the N1 nozzle between the two plants is the length of the nozzle and nozzle blend radius. The licensee stated that the relevant locations with respect to Code Case N-702 are the nozzle blend region and nozzle-to-shell weld. Since this difference in the length of the nozzle is at the far end of the nozzle where the wall thickness is more than 3.5 times thinner than the vessel wall, any stress due to piping/nozzle interface loads would be limited to safe-end portion of the nozzle. With respect to the difference in the nozzle blend radius, the Nine Mile Point 2 N1 nozzle blend radius is larger than that at Plant A, which results in lower peak surface stresses for the same applied load, but has little effect on through wall stress. The staff noted that consistent with BWRVIP-108 and BWRVIP-241, the stress of interest for the nozzle blend radius is the through-wall stress and not the peak surface stress. Based on the similarity in nozzle configuration and dimensions at the locations of interest between Nine Mile Point 2 and Plant A, the staff finds that the licensee adequately addressed this parameter for the purposes of its comparative evaluation.

Base Metal and Weld Chemistry

The licensee stated that the Nine Mile Point 2 N1 nozzle forging material chemistry contains 0.76 weight % Ni; however, the data on weight % Cu is not available. The licensee explained that the weld chemistry for the nozzle-to-shell weld is also not available for Nine Mile Point 2. The licensee explained that similarly, the plant-specific material chemistry for "Plant A" was not available, so generic data from the BWR fleet was used for both the nozzle forging and nozzle-to-shell weld material chemistry. The staff noted the material chemistry data (i.e., % Cu and % Ni) used in Plant A's PoF evaluation for the nozzle-to-shell weld and nozzle forging are

consistent with the chemistry used in BWRVIP-108 and BWRVIP-241, respectively. Furthermore, BWRVIP-108 indicates that the analyses performed in the report assumed the nozzle material chemistry is the same as the nozzle-to-shell weld chemistry and the worst weld chemistry from the BWR vessel fleet. Since not all of the plant-specific material chemistry was available, the staff finds it reasonable that the licensee used the generic data from the BWR fleet for Nine Mile Point 2 and that the licensee has adequately addressed this parameter for the purposes of its comparative evaluation.

Fluence

The licensee provided a summary of the fluence levels for Nine Mile Point 2 at the end of 60 years of reactor operation (i.e., 54 EFPY) that indicated that the fluence levels at the N1 and N6 nozzles will be 1.81×10^{16} n/cm^2 and 4.33×10^{17} n/cm^2, respectively. Furthermore, the maximum fluence levels at any of the nozzles at Nine Mile Point 2 will be 5.34×10^{17} n/cm^2. The licensee also provided a summary of the fluence levels for Plant A at the end of 60 years of reactor operation (i.e., 54 EFPY) for comparison The staff noted that the fluence levels at the N6 nozzle at Plant A will be 5.36×10^{17} n/cm^2, which is located in the beltline region. The fluence at the N6 nozzle for Plant A is the maximum for all nozzles at the plant; therefore, it was used in PoF analyses for the N1 nozzle. Based on a comparison of the fluence levels at both plants, the staff finds the fluence level used in Plant A's PoF analyses bounds the fluence level expected at the Nine Mile Point 2 N1 nozzle for 60 years of operation and that the licensee adequately addressed this parameter for the purposes of its comparative evaluation.

Thermal Transients

The licensee explained the Plant A evaluation is applicable to Nine Mile Point 2; however, for Nine Mile Point 2, the SRV blowdown transient is considered an upset event that needs to be addressed, whereas Plant A considered this event as an emergency event and was not considered in the PoF analyses. The licensee explained that in order to assess the impacts, the SRV blowdown transient was applied to the finite element model, and the stresses were extracted along paths representing the locations of a nozzle blend radius and nozzle-to-vessel weld. These stresses were then used as inputs into VIPERNOZ as an additional transient, and the cycle counts were increased to be representative of Nine Mile Point 2. Specifically, the total projected number of thermal cycles for Nine Mile Point 2 is 1,368 for 60 years. The staff noted that the VIPERNOZ computer program is the same program used in the BWRVIP-108NP report and was previously found acceptable for use as documented in the staff's SE. The licensee evaluated the effects of the Nine Mile Point 2 SRV blowdown transient on the PoF and determined that the effects of this transient resulted in a PoF that remains acceptable through the 60-year operating term (i.e., less than the NRC criterion of 5×10^{-6} per year). Based on the licensee's inclusion of the SRV blowdown transient and applicable cycle counts into the Nine Mile Point 2 N1 nozzle PoF analyses and determination that the PoF meets the NRC safety goal through the period of extended operation, the staff finds that the licensee adequately addressed this parameter for the purposes of its comparative evaluation.

Criterion 4 for the recirculation outlet nozzle (i.e., N1 nozzle), which is based on the generic analysis of BWRVIP-108 and BWRVIP-241, was not met. However, the licensee's comparative evaluation and the PFM results from Plant A indicate that the Nine Mile Point 2 recirculation outlet nozzles have PoF below the NRC criterion of 5×10^{-6} per year through the period of extended operation.

Based on the licensee's evaluation of the N2 nozzle compared to Criteria 4 and 5 of BWRVIP-241 and its comparative evaluation of the N1 nozzle and the PFM results from Plant A, the NRC staff determined that the reduced inspection requirements in Code Case N-702 apply to all proposed Nine Mile Point 2 RPV nozzles through the period of extended operation. The proposed alternative also provides an acceptable level of quality and safety because the conclusions from the licensee's comparative evaluation and the PFM results from Plant A meet the NRC safety goal on PoF through the period of extended operation.

4.0 CONCLUSION

The NRC staff has reviewed the submittal regarding the licensee's evaluation of the five criteria specified in the April 19, 2013, NRC staff SE for the BWRVIP-241 report, which provides technical bases for use of Code Case N-702, to examine RPV nozzle-to-vessel welds and nozzle inner radii at Nine Mile Point 1 and 2. As set forth above, the NRC staff determines that the licensee's proposed alternative provides an acceptable level of quality and safety and applies to all requested Nine Mile Point 1 and 2 RPV nozzles. However, this relief request does not include feedwater nozzles and control rod drive return nozzles. 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) and is in compliance with the ASME Code requirements.

Therefore, the NRC staff authorizes the licensee's proposed alternative to use Code Case N-702 for inspection of nozzle-to-vessel shell welds and nozzle inner radii sections of RPV nozzles listed in Section 3.1 of this SE for the remainder of the current 10-year intervals (fourth ISI interval for Unit 1 and third ISI interval for Unit 2), as well as each 10-year ISI interval during the remaining terms of the Nine Mile Point 1 and 2 Renewed Facility Operating Licenses, which currently expire on August 22, 2029, and October 31, 2046, respectively.

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.

Principal Contributor: On Yee

Date: December 5, 2017

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNITS 1 AND 2 – ALTERNATIVE TO THE REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE (CAC NOS. MF9381 AND MF9382; EPID L-2017-LLR-0015) DATED DECEMBER 5, 2017

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