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

March 6, 2017

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: BYRON STATION, UNIT NOS. 1 AND 2 – REQUEST FOR RELIEF FROM THE REQUIREMENTS OF THE ASME CODE (CAC NOS. MF8282 AND MF8283)

Dear Mr. Hanson:

By letter dated August 16, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16229A250) (submitted relief request I4R-10, Revision 0), as supplemented by letters dated December 29, 2016 (ADAMS Accession No. ML17003A274) (submitted relief request I4R-10, Revision 1), February 13, 2017 (ADAMS Accession No. ML17044A294) (submitted relief request I4R-10, Revision 2), and February 24, 2017 (ADAMS Accession No. ML17055B712), Exelon Generation Company, LLC (Exelon, the licensee) requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) regarding alternative requirements for repair of reactor vessel head penetrations (VHPs) at Byron Station, Unit Nos. 1 and 2 (Byron).

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

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). The NRC staff finds that the proposed alternative provides an acceptable level of quality and safety. Therefore, the NRC staff authorizes the use of the proposed alternative in relief request I4R-10, Revision 2, for the remainder of the fourth 10-year inservice inspection interval of Byron, which commenced on July 16, 2016, and is scheduled to end on July 15, 2025.

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

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

Sincerely,

Kimberly J. Green, Acting Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No.: STN 50-454, STN 50-455

Enclosure:
Safety Evaluation

cc w/encl: Distribution via ListServ

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. I4R-10, REVISION 2

REGARDING REACTOR VESSEL HEAD PENETRATIONS

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNIT NOS. 1 AND 2

DOCKET NOS. STN 50-454, STN 50-455

1.0 INTRODUCTION

By letter dated August 16, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16229A250), as supplemented by letters dated December 29, 2016 (ADAMS Accession No. ML17003A274), February 13, 2017 (ADAMS Accession No. ML17044A294), and February 24, 2017 (ADAMS Accession No. ML17055B712), Exelon Generation Company, LLC (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) regarding alternative requirements for repair of reactor vessel head penetrations (VHPs) at Byron Station, Unit Nos. 1 and 2 (Byron).

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

2.0 REGULATORY EVALUATION

The licensee proposes to use alternatives to the requirements of ASME Code, Section XI, IWA-4000, regarding removal of defects from and welded repair of VHPs.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and assess provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for In-service Inspection (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(g)(4)(ii), ISI examination of components during successive 120-month inspection intervals must comply with the requirements of the latest edition and addenda of the ASME Code incorporated by reference in paragraph (a) of 10 CFR 50.55a 12 months before the start of the 120-month inspection interval (or the optional ASME Code Cases listed in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 17, when using Section XI,

that are incorporated by reference in paragraphs (a)(3)(ii) and (iii) of 10 CFR 50.55a, subject to the conditions listed in paragraph (b) of 10 CFR 50.55a.

Pursuant to 10 CFR 50.55a(g)(6)(ii)(D), Augmented ISI requirements: Reactor vessel head inspections - All licensees of pressurized water reactors (PWRs) must augment their ISI program with ASME Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1," subject to the conditions specified in paragraphs (g)(6)(ii)(D)(2) through (6) of 10 CFR 50.55a.

Pursuant to 10 CFR 50.55a(z), alternatives to the requirements of paragraph (g) of 10 CFR 50.55a 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 licensee must demonstrate: (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.

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 NRC to authorize the alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Affected

The ASME Code Class 1 VHP nozzles and their associated partial penetration J-groove attachment welds are affected. In accordance with ASME Code Case N-729-1 (Table 1), the VHP nozzles and their associated attachment welds are classified as Item No. 4.20. Pursuant to 10 CFR 50.55a(g)(6)(ii)(D), Augmented ISI requirements: Reactor vessel head inspections - (1) All licensees of pressurized water reactors must augment their ISI program with ASME Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1," subject to the conditions specified in paragraphs (g)(6)(ii)(D)(2) through (6) of 10 CFR 50.55a.

The licensee provided the following information about the VHP penetration nozzles for which relief is requested.

Byron, Unit No. 1:

> Relief request (RR) I4R-10, Revision 2, applies to VHP nozzles number P-1 through P-78. Nozzle Nos. P-31, P-43, P-64, and P-76 were previously repaired.

Byron, Unit No. 2:

> RR I4R-10, Revision 2, applies to VHP nozzles number P-1 through P-78. Nozzle Nos. P-6, and P-68 were previously repaired.

3.2 Applicable Code Edition and Addenda

The code of record for the fourth 10-year ISI interval for Byron is the 2007 Edition through 2008 Addenda of the ASME Code, Section XI. Examinations of the VHPs are performed in

accordance with 10 CFR 50.55a(g)(6)(ii)(D), which specifies the use of Code Case N-729-1, with conditions.

The licensee stated that the Code of Construction for Byron is the 1971 Edition through summer 1973 Addenda of the ASME Code, Section III.

3.3 Duration of Relief

The licensee submitted RR I4R-10, Revision 2, (I4R-10) for the remainder of the fourth 10-year ISI interval at Byron which began on July 16, 2016, and is scheduled to end on July 15, 2025.

3.4 Applicable Code Requirements

ASME Code, Section XI, 2007 Edition through 2008 Addenda, subparagraph IWA-4000 contains requirements for the removal of defects from and welded repairs performed on ASME Code components. For the removal or mitigation of defects by welding, ASME Code, Section XI, IWA-4411 requires that repairs and installation of replacement items shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system.

The original Construction Code of the reactor vessel is ASME Code, Section III, 1971 Edition through summer 1973 Addenda. The licensee requests relief from the ASME Code, Section III, subparagraphs NB-4131, NB-2538, NB-2539.1, and NB-2539.4 which pertain to the removal of base material defects prior to repair by welding, and NB-4450, NB-4451, NB-4452, and NB-4453.1 which pertain to the removal of weld material defects prior to repair by welding.

3.5 Proposed Alternative and Basis for Use

As an alternative to the requirements of ASME Code Sections III and XI, VHPs would be repaired in accordance with Westinghouse Commercial Atomic Power (WCAP)-15987-P, Revision 2-P-A, "Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations," December 2003 (WCAP-15987-2) (ADAMS Accession No. ML040290246), with modifications, as described in Section 5.1 of the licensee's submittal. The proposed alternative includes ISI examination requirements for repairs previously completed at Byron in the third 10-year ISI interval.

3.6 Basis for Relief

The licensee stated that the embedded flaw repair (EFR) technique is considered a permanent repair. The licensee believes that as long as a primary water stress corrosion cracking (PWSCC) flaw remains isolated from the primary coolant environment, it cannot propagate. Further, the licensee reasons that since an Alloy 52 or 52M weldment is considered resistant to PWSCC, a new PWSCC flaw cannot initiate and grow through the Alloy 52 or 52M overlay to reconnect the primary water (PW) environment with the embedded flaw. Structural integrity of the affected J-groove weld and nozzle will be maintained by the remaining unflawed portion of the weld overlay.

The licensee stated that the residual stresses produced by the embedded flaw technique have been measured and found to be relatively low, indicating that no new flaws will initiate and grow in the area adjacent to the repair weld. Therefore, fatigue-driven crack growth is not a

mechanism for further crack growth into the Alloy 52 or 52M overlay after the EFR process is implemented.

According to the licensee, the small residual stresses produced by the embedded flaw will act constantly, and, therefore, will have no impact on the fatigue effects in this region. Since the residual stress would be additive to the maximum and minimum stress, the stress range will not change, and the already negligible fatigue usage factor for the region will not change.

In a letter dated February 13, 2017 (ADAMS Accession No. ML17044A294), the licensee submitted WCAP-16401, Revision 1, "Technical Basis for Repair Options for Reactor Vessel Head Penetration Nozzles and Attachment Welds: Byron and Braidwood Units 1 and 2," January 2017, which provides the plant-specific analysis performed for Braidwood and Byron using the same methodology as WCAP-15987-2. WCAP-16401 provides the means to evaluate a broad range of postulated repair scenarios to the VHP penetrations and J-groove welds relative to ASME Code requirements for allowable size and service life. The February 13, 2017, letter also includes the most recent revision of RR I4R-10, which is Revision 2.

3.7 NRC STAFF'S EVALUATION

The licensee requested authorization of its alternative RR I4R-10 under 10 CFR 50.55a(z)(1). The licensee requested to use the proposed alternative on the basis that its requirements for repair of VHPs provides an acceptable level of quality and safety.

By letter dated September 14, 2011 (ADAMS Accession No. ML111650286), the licensee proposed alternative IR3-20, Revision 1, to repair VHP nozzles using the emergency filter treatment (EFT) method, during the third 10-year ISI interval at Byron. The NRC approved the licensee's proposed alternative on March 29, 2012 (ADAMS Accession No. ML120790647). By letter dated September 8, 2014 (ADAMS Accession No. ML14251A536), as supplemented by letters dated May 29, 2015 (ADAMS Accession No. ML15149A424) and November 5, 2015 (ADAMS Accession No. ML15309A227), the licensee submitted proposed alternative RR IR3-20, Revision 2, to revise its previously approved alternative, IR3-20, Revision 1. Revision 2 was identical to Revision 1 with the exception that the licensee modified the frequency of ISI penetrant testing (PT) examinations of repaired J-groove welds that utilized the EFR method. The NRC approved the licensee's proposed alternative revision on January 21, 2016 (ADAMS Accession No. ML16007A185). The NRC staff evaluation of IR3-20, Revision 2, focused on the J-groove weld PT examination frequency modifications. Repairs during the third 10-years ISI interval using the EFT method are listed in Table 1 below. The current proposed alternative includes ISI examination requirements for EFT repairs previously completed.

Unit	Penetration	Repair Outage	Flaw Location
1	31	B1R17 (April 2011)	Attachment Weld
1	43	B1R17 (April 2011)	Attachment Weld
1	64	B1R17 (April 2011)	Penetration Nozzle
1	76	B1R17 (April 2011)	Penetration Nozzle
2	68	B2R13 (April 2007)	Penetration Nozzle and Attachment Weld (i.e., two flaw locations)
2	6	B2R18 (October 2014)	Attachment Weld

Table 1. Nozzles previously repaired at Byron by using the EFT method

The current proposed alternative, I4R-10, Revision 2, is applicable to the fourth ISI interval at Byron and is identical to the previously approved alternative (RR IR3-20, Revision 2), with the exception that the projected life of repaired attachment welds was increased from 10 years to 40 years. Byron entered the fourth 10-year ISI interval on July 16, 2016.

The purpose of the licensee's proposed repair is to address PWSCC, which typically initiates in susceptible materials, such as alloy 600 material and alloy 82/182 weld materials, in areas of tensile stress and certain environmental conditions, such as higher temperatures and corrosive environments. The reactor VHPs and their associated J-groove attachment welds at Byron meet these conditions and are therefore susceptible to PWSCC. The proposed repair technique isolates the susceptible material using a seal weld of alloy 52M weld material, which is less susceptible to PWSCC.

The licensee's basis for the design, implementation, and inspection of the repairs for VHPs is WCAP-15987, Revision 2-P-A. In a letter dated July 3, 2003, from H. N. Berkow (NRC) to H. A. Sepp (Westinghouse Electric Company), (ADAMS Accession No. ML031840237) the NRC staff provided a safety evaluation (SE), in which the NRC staff found WCAP-15987-2 to be acceptable for referencing in licensing applications as an alternative to Section XI of the ASME Code, with the following conditions:

1. Licensees must follow the NRC flaw evaluation guidelines provided in the R. J. Barrett (NRC) letter to A. Marion (Nuclear Energy Institute), "Flaw Evaluation Guidelines," April 11, 2003. (ADAMS Accession No. ML030980322)

2. The crack growth rate referenced in WCAP-15987-P, Revision 2 is not applicable to Alloy 600 or Alloy 690 weld material, i.e., Alloy 52, 82, 152, and 182 filler material.

3. The nondestructive examination (NDE) requirements listed in the table below must be implemented for examinations of repairs made using the embedded flaw process.

Repair Location	Flaw Orientation	Repair Weld	Repair NDE	ISI NDE of the Repair Note 2
VHP Nozzle ID (inside diameter)	Axial	Seal	UT (ultrasonic testing) and Surface	UT or Surface
VHP Nozzle ID	Circumferential	Note 1	Note 1	Note 1
VHP Nozzle OD (outside diameter) above j-groove weld	Axial or Circumferential	Note 1	Note 1	Note 1
VHP Nozzle OD below j-groove weld	Axial or Circumferential	Seal	UT or Surface	UT or Surface
j-groove weld	Axial	Seal	UT and Surface, Note 3	UT and Surface, Note 3
j-groove weld	Circumferential	Seal	UT and Surface, Note 3	UT and Surface, Note 3

Notes:

1. Repairs must be reviewed and approved separately by the NRC.
2. Inspection consistent with the NRC Order EA-03-009 dated February 11, 2003, and any subsequent changes (ADAMS Accession No. ML030380470).
3. Inspect with personnel and procedures qualified with UT [ultrasonic testing] performance-based criteria. Examine the accessible portion of the repaired region. The UT coverage plus surface coverage must equal 100 percent.

The licensee stated that their proposed alternative will use the methodology of the NRC approved WCAP-15987-2 as described by Section 5.1 of its August 16, 2016, submittal, with some modification. NRC staff reviewed Section 5.1 to ensure the licensee's proposed actions would meet the requirements of WCAP-15987-2 and any modifications would be acceptable under 10 CFR 50.55a(z)(1). As part of this review the NRC staff identified the following technical changes between the requirements of WCAP-15987-2, and Section 5.1, of the licensee's submittal:

A. The Alloy 600 tube material with a flaw will be repaired with two Alloy 52 isolation weld layers rather than three layers required in WCAP-15987-2-A.

B. A circumferential flaw on the nozzle or tube inside diameter can be repaired using the seal weld technique without additional submission of the repair method for approval by the NRC.

C. Prior to the application of the Alloy 52 or 52M seal weld repair on the RPV clad surface, the stainless steel head cladding will have three beads of 309L stainless steel installed 360 degrees around the interface of the clad and the J-groove weld metal as a buffer layer. The J-groove weld will be covered with three layers of Alloy 52/52M deposited 360 degrees around the nozzle over and extend to the stainless steel buffer layer.

D. In accordance with Notes 2 and 3 of the NRC acceptance for WCAP-15987-P-A, Revision 2, the NDE of the repair will be performed in accordance with ASME Code Case N-729-1, as conditioned by 10 CFR50.55a(g)(6)(ii)(D).

E. Surface examination of the EFR, for repaired J-groove welds, shall be performed to ensure the repair satisfies ASME Section III, NB-5350 acceptance standards. The frequency of examination shall be as follows:

    a. Perform surface examination during the first and second refueling outage after installation or repair of the EFR.

    b. When the examination in a. above verify acceptable results, then re-inspection of the EFR will be continued at a frequency of every other refueling outage. If these examinations identify unacceptable results that require flaw removal, flaw reduction to acceptable dimensions or welded repair the requirements of a. above shall be applied during the next refueling outage.

    The inspection frequency described in a. and b. above is in lieu of performing re-inspections every refueling outage.

The NRC staff reviewed the licensee's proposal in paragraph A, above, to allow a reduction in the maximum three layers of the seal weld over the Alloy 600 nozzle material to only two layers. The licensee's basis is that the flaw would be isolated from the primary coolant environment necessary for continued PWSCC growth with less stress being introduced in the base metal with the proposed repair. The NRC staff finds that operational experience has shown that two layers of Alloy 52 material have been sufficient to address dilution layer effects of the high chromium content of the Alloy 52 material, which is the principle reason for the material's resistance to PWSCC. In addition, the concern of increased residual stresses in the Alloy 600 material that might still be exposed to primary coolant is a cause for concern for future flaw initiation. Therefore, since the repair can be effective using two weld layers, a smaller seal weld that generates less weld residual stresses in the base metal, would be more preferable than using three weld layers. Therefore, the NRC staff finds this change to be acceptable.

The NRC staff reviewed the licensee's proposal in paragraph B, above, which removes the necessity for the licensee to submit a repair plan for each circumferential flaw identified that initiates from the inside diameter of the tube or nozzle surface. The licensee detailed a generic repair plan in accordance with Section 5.1.2.1.a of the licensee's submittal. The licensee's proposed alternative repair would be to partially excavate the flaw to reduce it to an acceptable size, examine it by UT or surface examination, inlay with Alloy 52 or 52M, and examine by UT and surface examination. This is in compliance with the embedded flaw technique. Further, operational experience has shown this repair technique is effective in arresting growth of PWSCC flaws. Therefore, the NRC staff finds the generic repair plan is effective in addressing circumferential flaws that initiate on the inside tube or nozzle surface. The NRC staff finds this change to be acceptable.

The NRC staff reviewed the licensee's proposal in paragraph C above that the stainless steel (SS) head cladding will have three beads of SS 309L buffer layer installed 360 degrees around the interface of the clad and the J-groove weld metal. The NRC staff notes that it is common practice to apply a buffer layer of SS weld metal over existing SS base material or existing SS weld metal before applying Alloy 52. Existing SS material may potentially contain levels of sulphur, phosphorous and silicon that can contribute to weld solidification cracking when diluted into Alloy 52 welds. Applying a buffer layer of SS weld metal that contains controlled levels of these elements, which can be detrimental to Alloy 52 welds, decreases the potential for weld cracking. The NRC staff finds the proposed alternative to be appropriate as the buffer layer of SS 309L weld metal will improve weld quality by decreasing the potential for welding defects at the SS cladding/Alloy 52 interface.

The NRC staff reviewed the licensee's proposal in paragraph D above, for alternatives for NDE examination requirements of the seal weld and future ISI requirements. During the time period in which WCAP-15987-2 was approved by the NRC staff, the regulatory requirements for upper head inspection were dictated under NRC Order EA-03-009. In September 2008, by rule, the NRC established 10 CFR 50.55a(g)(6)(ii)(D) which defines the current regulatory requirements for upper head inspections and rescinded NRC Order EA-03-009. The NRC staff finds that the licensee's proposed alternative inspections for the upper head penetration nozzles under the current regulatory guidelines of ASME Code Case N-729-1, "Alternative Examination Requirements for PWR Reactor Vessel Upper Heads With Nozzles Having Pressure-Retaining Partial-Penetration Welds, Section XI, Division 1," satisfy the previous NRC conditions on the NDE required for implementation of an EFR under WCAP-15987-2. Therefore, the NRC staff finds these changes to be acceptable.

The NRC staff reviewed the licensee's proposal in paragraph E above, regarding alternatives for ISI of repaired J-groove welds. The licensee proposes to perform PT examinations of repaired J-groove welds for the first two outages after the repairs and then every other outage in lieu of every outage following J-groove weld repairs. The alternative in paragraph E and the licensee's supporting information are identical to the previous NRC approved alternative for Byron, as described in the NRC staff SE of RR IR3-20, Revision 2, dated January 21, 2016 (ADAMS Accession No. ML16007A185). The NRC staff is unaware of any plant operating conditions or industry operating experience that would invalidate the staff's previous conclusion. Therefore, the NRC staff finds the staff's previous conclusion applicable to the current RR I4R-10 and finds alternative described in Paragraph E acceptable.

Based on the above, the NRC staff finds that the changes in the license's proposed alternative from the NRC approved WCAP-15987-2, either meet or provide additional quality for the EFR technique and as such provide an acceptable level of quality and safety.

In order to support the use of WCAP-15987-2 with a plant specific technical basis for the use of the EFR, the licensee previously submitted WCAP-16401 Revision 0, "Technical Basis for Repair Options for Reactor Vessel Head Penetration Nozzles and Attachment Welds: Byron and Braidwood Units 1 and 2," Revision 0, March 2005, to support its third 10-year ISI interval request. In its August 16, 2016, submittal, the licensee referenced WCAP-16401, Revision 0, as being applicable to its current request. WCAP-16401, Revision 0, provides a basis for any remaining ligaments of the flaws identified by the licensee in VHP nozzle base material to be safely encapsulated for 20 years of operation and for any remaining ligaments of the flaws identified by the licensee in VHP nozzle J-groove weld material to be safely encapsulated for 10 years of operation. The NRC staff noted that Revision 0 of WCAP-16401 does not support continued operation of J-groove weld repairs, identified in Table 1 above, through the end of the current fourth 10-year ISI interval which is scheduled to end in July 15, 2025. As such, this document does not support the Revision 0 of relief request I4R-10.

To resolve its position that WCAP-16401, Revision 0, does not support relief request, I4R-10, Revision 0, the NRC staff requested that the licensee provide additional information to support the continued operation of previously repaired J-groove welds for the remainder of the fourth 10-year ISI interval. By letter dated February 13, 2017, the licensee submitted WCAP-16401, Revision 1, "Technical Basis for Repair Options for Reactor Vessel Head Penetration Nozzles and Attachment Welds: Byron and Braidwood Units 1 and 2," in January 2017, which was revised to address the limited 10-year life of J-groove weld repairs. The licensee also provided additional clarifying information, by letter dated February 24, 2017, regarding the modifications that were made in WCAP-16401, Revision 1. The licensee stated that its initial evaluation, in WCAP-16401, Revision 0, used conservative bounding inputs that resulted in a service life that did not challenge or limit the expected duration of flaw life due to anticipated replacement of the reactor pressure vessel (RPV) heads at Byron and Braidwood Stations. The licensee subsequently elected to peen the RPV heads as a PWSCC mitigating measure resulting in the existing EFRs remaining for the life of the plant; necessitating a reevaluation of the EFR service life for J-groove welds. The reevaluation, in WCAP-16401, Revision 1, included modifying the assumed flaw aspect ratio for the uphill nozzle location from 6 to 2 and modifying the pressure used in the analysis from a design pressure of 2500 psia (pounds per square inch absolute) to an operating pressure, 2250 psia. The licensee contends that the previous flaw aspect ratio and system pressure used in the analysis, as documented in WCAP-16401, Revision 0, were overly conservative and the current input values, as documented in WCAP-16401, Revision 1, are more realistic. The NRC staff reviewed the licensee's use of a flaw aspect ratio of 2. The staff notes that an aspect ratio of 2 bounds all uphill nozzle location J-groove weld geometries,

as shown in WCAP-16401, Revision 1, Table 3-1 (Attachment 1 of the licensee's February 13, 2017, supplement). Therefore, the staff finds that the licensee's use of a flaw aspect ratio of 2 is acceptable. The licensee's use of the operating pressure, in lieu of the design pressure, is acceptable because the use of the operating pressure is consistent with ASME Code Section XI, Appendix A.

As shown in Figure 2 of the licensee's February 24, 2017, letter, the use of an aspect ratio of 2 for uphill nozzles and an operating pressure of 2250 psia results in postulated flaw size of approximately 2.8 inches at 40 years of service life. Figure 2 also shows that the time to reach the calculated allowable flaw size of 3.0 inches is greater than 40 years of service life. The NRC staff finds the use of an aspect ratio of 2 acceptable because the postulated flaw size is calculated to be less than the allowable flaw size of 3.0 inches after 40 years of operation.

WCAP-16401, Revision 1, states that "Engineering evaluations were performed and the results are presented in this report to provide the maximum flaw sizes that would satisfy the requirements in Section XI of the ASME Code [2004 Edition]." The NRC staff requested that the licensee verify that all of the analyses, documented in WCAP-16401-P Revision 1, meet the ASME Code Section XI, 2007 Edition with the 2008 Addenda, which is the applicable Code Edition and Addenda for the fourth 10-year ISI interval at Byron Units 1 and 2. In the licensee's February 24, 2017 letter, it indicated that the methodologies used in the evaluations contained in WCAP-16401-P, Revision 1 are consistent with the requirements of Appendix A and Appendix K of Section XI and that there are no differences between ASME Code Section XI, 2004 Edition and the 2007 Edition/2008 Addenda. The licensee stated that the WCAP-16401, Revision 1, results and conclusions between 2004 Edition and the 2007 Edition/2008 Addenda would be the same. The NRC staff finds this acceptable because the evaluation documented in WCAP-16401, Revision 1, is consistent with the current code of record at Byron.

The NRC staff finds WCAP-16401, Revision 1, provides a basis for any remaining ligaments of the flaws identified by the licensee in VHP nozzle base material to be safely encapsulated for 20 years of operation. The NRC staff finds WCAP-16401, Revision 1, provides a basis for any remaining ligaments of the flaws identified by the licensee in VHP nozzle J-groove weld material to be safely encapsulated for 40 years of operation.

In accordance with the previous NRC conditions imposed on the use of WCAP-15987-2, and plant-specific technical basis for the EFR, the NRC staff confirms that the licensee has followed the NRC flaw evaluation guidelines and will implement the appropriate NDE for the repairs to VHP nozzles and their associated J-groove welds at Byron. In accordance with the July 3, 2003, NRC SE, the EFR process is considered to be an alternative to Code requirements that provides an acceptable level of quality and safety, as required by 10 CFR 50.55a(z)(1).

4.0 CONCLUSION

Based on the above evaluation, the NRC staff finds that the proposed alternative 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). Therefore, the NRC staff authorizes the use of the proposed alternative in I4R-10, Revision 2, for the remainder of the fourth 10-year ISI interval of Byron which commenced on July 16, 2016, and is scheduled to end on July 15, 2025.

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

Principal Contributor: R. Davis, NRR

Dated: March 6, 2017

SUBJECT: BYRON STATION, UNIT NOS. 1 AND 2 – REQUEST FOR RELIEF FROM THE REQUIREMENTS OF THE ASME CODE (CAC NOS. MF8282 AND MF8283) DATED MARCH 6, 2017

DISTRIBUTION:
PUBLIC
LPL3 R/F
RidsACRS_MailCTR Resource
RidsNrrDorlDpr Resource
RidsNrrDorlLpl3 Resource
RidsNrrDeEpnb Resource
RidsNrrLASRohrer Resource
RidsNrrPMByron Resource
RidsRgn3MailCenter Resource
JBowen, EDO R3

ADAMS Accession No. ML17062A428 *via e-mail

OFFICE	DORL/LPL3/PM	DORL/LPL3/LA	DE/EPNB/BC	DORL/LPL3/BC (A)
NAME	JWiebe	SRohrer	DAlley*	KGreen
DATE	3/6/17	3/6/17	3/2/17	3/6/17

OFFICIAL RECORD COPY