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

February 1, 2012

Mr. Michael J. Pacilio
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNIT NO. 1 - INSERVICE INSPECTION RELIEF REQUEST I3R-19: ALTERNATIVE REQUIREMENTS FOR THE REPAIR OF REACTOR VESSEL HEAD PENETRATIONS (TAC NOS. ME5877 AND ME5948)

Dear Mr. Pacilio:

By letters to the U.S. Nuclear Regulatory Commission (NRC), dated March 24, March 25, March 31, April 8, April 10 (two letters), and April 26, 2011, Exelon Generation Company, LLC (EGC, the licensee) submitted a relief request (RR) I3R-19 as an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, associated with repair of reactor vessel head penetration (RVHP) Nos. 31, 43, 64, and 76, and associated J-groove welds at Byron Station, Unit No. 1 (Byron U1).

Specifically, pursuant to Title 10 of the *Code of Federal Regulation* (10 CFR) 50.55a(a)(3)(i), the licensee requested approval to use an alternative to the ASME Code on the basis that the alternative provides an acceptable level of quality and safety.

On March 28, 2011, NRC staff granted a verbal authorization on the use of proposed repair alternative RR I3R-19 for RVHP Nos. 64, and 76 at Byron U1. Additionally, on March 31, the licensee requested that the NRC staff authorize the proposed alternative repair of RR I3R-19 for RVHP Nos. 31, and 43. On April 10, 2011, NRC staff verbally authorized the alternative repair for RVHP Nos. 31, and 43. Subsequently, by letter dated April 26, 2011, the licensee withdrew the Byron U1 generic portion of RR I3R-19 which was applicable to each RVHP. Instead, the alternative repair was requested specifically for the four seal weld repairs on RVHP Nos. 31, 43, 64, and 76. Furthermore, the licensee withdrew the requested NB-4450 alternative requirements for RVHP Nos. 31, and 64.

The NRC has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the proposed alternative repair provides an acceptable level of quality and safety, and that EGC has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i). Therefore, the NRC staff authorizes EGCs proposed alternative, RR IR3-19, for RVHP Nos. 31, 43, 64, and 76, as supplemented for the remainder of the third 10-year inservice inspection interval which is scheduled to conclude on July 15, 2016.

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. The NRC staff's safety evaluation is enclosed.

Please contact Brenda Mozafari at (301) 415-2020 if you have any questions on this action.

Sincerely,

Jacob I. Zimmerman, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. STN 50-454

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

INSERVICE INSPECTION REQUEST FOR RELIEF I3R-19: ALTERNATIVE REQUIREMENTS FOR THE REPAIR OF REACTOR VESSEL HEAD PENETRATIONS

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNIT NO. 1

DOCKET NO. STN 50-454

1.0 INTRODUCTION

By letters to the U.S. Nuclear Regulatory Commission (NRC, the Commission), dated March 24, March 25, March 31, April 8, April 10 (two letters), and April 26, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML110830837, ML110870236, ML110910156, ML111010535, ML111010202, ML111010199 and ML111170267, respectively), Exelon Generation Company LLC (EGC, the licensee) submitted a relief request (RR) I3R-19 as an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) associated with repair of reactor vessel head penetration (RVHP) Nos. 31, 43, 64, and 76, and associated J-groove welds at Byron Station, Unit No. 1 (Byron U1). In the March 25, 2011, letter, the licensee made a regulatory commitment detailed in Section 5.

The NRC staff reviewed the licensee's submittal and determined that the proposed alternative to repair RVHP Nos. 64, and 76 at Byron U1 provided an acceptable level of quality and safety. During a conference call with the licensee on March 28, 2011, and by subsequent memorandum (ADAMS Accession No. ML110840512), dated March 29, 2011, the NRC staff verbally authorized the use of proposed repair alternative RR I3R-19 for RVHP Nos. 64, and 76 in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(i). In the March 31, 2011, letter, the licensee requested that the NRC staff authorize the proposed alternative repair of I3R-19 for RVHP Nos. 31, and 43, as well. During a conference call with the licensee on April 10, 2011, and by subsequent memorandum dated April 13, 2011 (ADAMS Accession No. ML110910380), NRC verbally authorized RR I3R-19 for the repair of RVHP Nos. 31, and 43 at Byron U1.

2.0 REGULATORY EVALUATION

The inservice inspection (ISI) of ASME Code Class 1, 2, and 3, components is to be performed in accordance with the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant components," and applicable editions and addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission. Pursuant to 10 CFR 50.55a(g)(4), throughout the service life of a pressurized water-cooled nuclear power

facility, components which are classified ASME Code, Class 1, 2, and 3, must meet the requirements, except the design and access provisions and preservice examination requirements, set forth in the ASME Code, Section XI, to the extent practical within the limitations of design, geometry and materials of construction of the components. Further, these regulations require that inservice 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 paragraph (b) of 10 CFR 50.55a, 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. For Byron U1, the ASME Code of Record for the third 10-year ISI interval, which is currently scheduled to end on July 15, 2016, is the 2001 Edition through the 2003, Addenda.

Alternatives to requirements may be authorized or relief granted by the NRC pursuant to 10 CFR 50.55a(a)(3)(i), 10 CFR 50.55a(a)(3)(ii), or 10 CFR 50.55a(g)(6)(i). In proposing alternatives or requests for relief, the licensee must demonstrate that: (1) the proposed alternatives would provide an acceptable level of quality and safety; (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety; or (3) conformance is impractical for the facility.

By letter dated March 24, 2011, the licensee proposed alternative RR I3R-19, in accordance with 10 CFR 50.55a(a)(3)(i), for the repair of RVHP nozzles and associated J-groove welds at Byron U1 for the plant's third 10-year ISI interval.

3.0 TECHNICAL EVALUATION

3.1 Component Identification

Byron U1 RVHPs for Nos. 31, 43, 64, and 76.

3.2 ASME Code Requirements for Which Relief is Requested

In ASME Code, Section XI, 2001, Edition through 2003 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 the 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-4451, NB-4452, and NB-4553.1, which pertain to the removal of weld material defects prior to repair by welding.

3.3 Licensee's Proposed Alternative

As an alternative, the proposed repair will be conducted in accordance with the appropriate edition of ASME Code, Section III, and the alternative requirements, based on WCAP-15987,

Revision 2-A, "Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations," December 2003 (ADAMS Accession No. ML040290246), with the following:

> The stainless steel head cladding will have three beads of 309L stainless steel buffer installed 360° (degrees) around the interface of the clad and the J-groove weld metal at Penetration 31, 43, 64, and 76. The J-groove weld will have three layers of Alloy 52/52M deposited 360 degrees around the nozzle over and out to the stainless steel buffer.
>
> The nozzle tube will have two layers of Alloy 52/52M deposited 360° around the nozzle and tied into the J-groove overlay. On Penetration 76, the nozzle tube will have the overlay extend down to the lowest possible location that will allow reinstallation of the funnel. On Penetrations 31, 43, and 64, the nozzle tube will be overlayed to the bottom of the nozzle (i.e., no funnel is installed).
>
> In accordance with Note 3 of the NRC acceptance for WCAP-15987-P-Revision 2, the final NDE [nondestructive examination] performed on penetrations Nos. 31, 43, 64, and 76, will include UT [ultrasonic test] of the nozzle and PT [penetrant test] of the overlayed area. This will constitute 100% of the required examinations for the final NDE on the repairs during B1 R17.
>
> For the ISI NDE of the repair for Penetrations 64, and 76 starting with refueling outage B1 R18, Note 3 does not apply since the repair location is in the "VHP Nozzle OD [outside diameter] below J-groove weld." Therefore, ISI NDE of the repair for Penetrations 64, and 76 will be performed in accordance with Code Case N-729-1, as amended by 10 CFR 50.55a(g)(6)(ii)(D).

3.4 Licensee's Duration of Relief Request

The licensee requested relief for the remainder of the third 10-year ISI interval at Byron U1, which is currently scheduled to end on July 15, 2016.

3.5 Licensee's Basis for Relief

The licensee states that the embedded flaw repair 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 highly resistant to PWSCC, a new PWSCC flaw cannot initiate and grow through the Alloy 52 or 52M overlay to reconnect the primary water 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 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 after the embedded flaw repair process is implemented.

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 usage factor for the region will not change.

The WCAP-16401 provides the plant-specific analysis performed for Byron U1 using the same methodology as WCAP-15987-P, Revision 2-P-A. This analysis provides the means to evaluate a broad range of postulated repair scenarios to the RVHPs and J-groove welds relative to ASME Code requirements for allowable size and service life.

4.0 NRC STAFF'S EVALUATION

The licensee requested authorization of this revised alternative RR I3R-19 under 10 CFR 50.55a(a)(3)(i) which states: The proposed alternatives would provide an acceptable level of quality and safety.

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 RVHPs and their associated J-groove attachment welds at Byron U1 meet these conditions to be susceptible to PWSCC. The proposed repair technique isolates the susceptible material using a weld overlay of Alloy 52M weld material, which is less susceptible to PWSCC. In order to ensure complete coverage of all greater PWSCC susceptible material, the weld overlay extends an additional ½-inch beyond the outer ring of the original J-groove weld onto the stainless steel cladding covering on the inside surface of the head. PWSCC is not considered a degradation mechanism that would affect the structural integrity of the stainless steel clad low alloy steel head.

The licensee's bases for the design, implementation, and inspection of the repairs for vessel head penetration of Nos. 31, 43, 64, and 76, is Westinghouse WCAP-15987, Revision 2 (ADAMS Accession No. ML031410262). 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, in which the staff found WCAP-15987-2 to be acceptable for referencing in licensing applications as an alternative to the 2001 Edition, 2003 Addenda of Section XI of the ASME Code, with the following limitations:

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
RVHP 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.

3. Inspect with personnel and procedures qualified with ultrasonic test (UT) performance-based criteria. Examine the accessible portion of the repaired region. The UT coverage plus surface coverage must equal 100 percent.

The licensee states that their proposed alternative meets, and, with respect to, NDE updates to the methodology of the NRC-approved WCAP-15987-2. NRC staff reviewed I3R-19 to ensure the licensee's proposed actions would meet the requirements of WCAP-15987-2. NRC staff verified that the changes in I3R-19 in the application of the seal weld (using a stainless steel buffer and extent of the seal weld) and NDE (updating the requirements from the NRC Order EA- 03-009, to the current NDE regulatory requirements for upper head penetration nozzle inspections under 10 CFR 50.55a(g)(6)(ii)(D) and ASME Code Case N-729-1), would still meet the methodology approved by the NRC in WCAP-15987-2, and provide an acceptable level of quality and safety.

The NRC staff reviewed the licensee proposal that the stainless steel head cladding will have three beads of 309L stainless steel buffer installed 360 °F around the interface of the clad and the J-groove weld metal at penetration Nos. 31, 43, 64, and 76. The licensee's application of this layer is to prevent contamination of the Alloy 52 weld wire which is susceptible to fabrication defects. The NRC staff finds the proposed alternative to be appropriate as the Alloy 52 weld is less susceptible to PWSCC than the Alloy 182 weld at the existing nozzle penetration and will fully cover the Alloy 182 weld material. In addition, the 309L layer, applied only to the periphery, will allow for a better-quality seal weld.

The NRC staff reviewed the licensee's proposed alternative application of the seal weld and found it goes beyond the requirements of WCAP-15987- 2. The WCAP states in Section 2.2.3, for axial cracks on the penetration tube outside diameter below the J-groove weld, that the overlay begins ½-inch beyond the Alloy 600/stainless steel interface at the outer periphery of the J-groove weld and extends down the outer surface of the penetration tube to a point ½-inch beyond the flaw indication. Section 2.2.4, states that, for circumferential cracks in the penetration tube, the scope of the weldment is not specific other than isolation of the flaw. The

licensee stated that the seal weld would begin ½-inch beyond the Alloy 600 stainless steel interface at the outer periphery of the J-groove weld and extend down the outer surface of the penetration tube to the bottom of the nozzle for RVHP Nos. 31, 43, 64, or to the lowest possible location that will allow reinstallation of the funnel for RVHP 76. The NRC staff finds the licensee's seal weld satisfies the requirements of Sections 2.2.3 and 2.2.4 of WCAP-15987-2.

The NRC staff reviewed the licensee's proposed 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 was found 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 nozzle Nos. 31, 43, 64, and 76, under the current regulatory guidelines, satisfy the previous NRC limitations on the NDE required for implementation of an embedded flaw repair under WCAP-15987-2.

Therefore, 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 embedded flaw repair technique and, as such, provides 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 embedded flaw repair, the licensee previously submitted Westinghouse WCAP-16401, "Technical Basis for Repair Options for Reactor Vessel Head Penetration Nozzles and Attachment Welds: Byron and Braidwood Units 1 and 2," in a letter dated May 3, 2007 (ADAMS Accession No. ML071310117). The NRC staff finds WCAP-16401 provides a basis for any remaining ligaments of the flaws identified by the licensee in RVHP nozzle Nos. 64, and 76 to be safely encapsulated for 20 years of operation. The staff finds WCAP-16401 provides a basis for any remaining ligaments of the flaws identified by the licensee in RVHP nozzle Nos. 31 and 43 to be safely encapsulated for 10 years of operation.

The licensee addressed the crack growth rate applicable to Alloy 600 or Alloy 690 weld material, (i.e., Alloy 52, 82, 152, and 182 filter material) by applying upper head penetration nozzle inspections under 10 CFR 50.55a(g)(6)(ii)(D) and ASME Code Case N-729-1. The NRC staff found that these changes in I3R-19 still meet the methodology approved by the NRC in WCAP-15987-2, and provide an acceptable level of quality and safety.

The NRC staff has previously approved this proposed alternative repair method as adequate to allow weld repairs of embedded axial and circumferential flaws in the outside diameter surface of RVHP nozzles at or below the J-groove weld and similar flaws in the J-groove weld itself at D.C. Cook, Unit 1, Beaver Valley Generating Station, Units 1 and 2, San Onofre Power Station, Units 2 and 3, and Byron Station, Unit No. 2.

In accordance with the previous NRC limitations on the use of WCAP-15987-2, and plant-specific technical basis for the embedded flaw repair, the NRC staff confirms that the licensee has followed the NRC flaw evaluation guidelines and will implement the appropriate NDE for the repairs to RVHP nozzle Nos. 31, 43, 64, and 76, and their associated J-groove welds at Byron U1. In accordance with the July 3, 2003, safety evaluation, the embedded flaw repair process is

considered to be an alternative to ASME Code requirements that provides an acceptable level of quality and safety, as required by 10 CFR 50.55a(a)(3)(i).

5.0 REGULATORY COMMITMENT

In support of the proposed RR, the licensee provided the following regulatory commitment in its supplemental letter dated March 25, 2011:

> Exelon Generation Company, LLC (EGC) will notify NRC staff of the [Division of Engineering] or its successor of changes in indication(s) or findings of new indication(s) in the penetration nozzle or J-groove weld beneath a seal weld repair, or new linear indications in the seal weld repair, prior to commencing repair activities.

The licensee committed to the above on a programmatic basis beginning with Byron U1 refueling outage 18.

6.0 CONCLUSIONS

As set forth above, the NRC staff concludes that the licensee provided sufficient technical basis to support that the proposed alternative repair 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(a)(3)(i), and is in compliance with the ASME Code requirements. Therefore, the NRC staff authorizes the licensee's proposed alternative, RR IR3-19, for RVHP Nos. 31, 43, 64, and 76, for the remainder of the third 10-year ISI interval which is scheduled to conclude on July 15, 2016.

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

Principal Contributor: J. Collins, NRR

Date of issuance: February 1, 2012

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. The NRC staff's safety evaluation is enclosed.

Please contact Brenda Mozafari at (301) 415-2020 if you have any questions on this action.

Sincerely,
/RA/

Jacob I. Zimmerman, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. STN 50-454

Enclosure:
Safety Evaluation

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