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

December 20, 2016

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 I4R-06, RELIEF FROM THE REQUIREMENTS OF THE ASME CODE (CAC NOS. MF7643 AND MF7644)

Dear Mr. Hanson:

By letter dated April 15, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16106A116), Exelon Generation Company, LLC (Exelon) submitted relief request I4R-06 to the U.S. Nuclear Regulatory Commission (NRC), requesting approval of alternative repair criteria for American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, 2007 Edition with the 2008 Addenda, Class 2 and 3 moderate energy carbon steel piping systems in accordance with ASME Code Case N-786, "Alternative Requirements for Sleeve Reinforcement of Class 2 and 3 Moderate-Energy Carbon Steel Piping Section XI, Division 1." The request is applicable to Byron Station, Unit Nos. 1 and 2. Other relief requests included in the April 15, 2016, letter will be addressed under separate correspondence.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee requested to use the proposed alternative on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the 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 reasonable assurance of structural integrity and leak tightness of the subject components and that complying with ASME Code, Section XI, IWA-4400, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the staff authorizes the use of the proposed alternative described in the licensee's April 15, 2016, letter, for the fourth 10-year ISI interval at Byron Station, Unit Nos. 1 and 2, or until the NRC approves Code Case N-786 for general use through rulemaking and revision to NRC Regulatory Guide 1.147, whichever comes first.

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

Sincerely,

David J. Wrona, Chief
Plant Licensing Branch 3
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos.: STN 50-454, STN 50-455

Enclosure:
Safety Evaluation

cc w/encl: Distribution via ListServ

UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PROPOSED ALTERNATIVE TO UTILIZE CODE CASE N-786

10 CFR 50.55A REQUEST NO. I4R-06

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNIT NOS. 1 AND 2

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

1.0 INTRODUCTION

By letter dated April 15, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16106A116), Exelon Generation Company, LLC (the licensee) submitted a proposed alternative to the requirements of Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for Byron Station, Unit Nos. 1 and 2, regarding the repair or replacement of degraded piping.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee proposed to use ASME Code Case N-786, "Alternative Requirements for Sleeve Reinforcement of Class 2 and 3 Moderate-Energy Carbon Steel Piping, Section XI, Division 1," with specified modifications, in lieu of specified ASME Code requirements, on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

2.0 REGULATORY EVALUATION

The licensee's request proposes an alternative to the requirements of ASME Code, Section XI, Article IWA-4000, regarding the repair or replacement of degraded piping pursuant to 10 CFR 50.55a(z)(2).

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

The regulation in 10 CFR 50.55a(z) states, in part, that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if the licensee demonstrates that: (1) the proposed alternative provides an acceptable level of quality and

safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

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

3.0 TECHNICAL EVALUATION

3.1 Licensee's Relief Request

3.1.1 Components for Which Relief is Requested

The affected components are ASME Code, Class 2 and 3, moderate energy carbon steel piping systems that carry fluid at a maximum operating temperature and pressure of less than or equal to 200 degrees Fahrenheit and less than or equal to 275 pound per square inch gauge, respectively.

3.1.2 Applicable ASME Code Edition and Addenda

The fourth 10-year interval of the Byron Station, Unit Nos. 1 and 2, inservice inspection (ISI) program began on July 16, 2016, and is scheduled to end on July 15, 2025. The applicable Code of Record for the fourth 10-year interval is ASME Code 2007 Edition with the 2008 Addenda.

3.1.3 Applicable Code Requirement

ASME Code, Section XI, IWA-4400, of the 2007 Edition with the 2008 Addenda provides requirements for welding, brazing, metal removal, and installation of repair/replacement activities.

3.1.4 Proposed Alternative and Basis for use

Pursuant to 10 CFR 50.55a(z)(2), the licensee requests a proposed alternative to the requirements of ASME Code, Section XI, IWA-4000, to repair degradation in ASME Code, Class 2 and 3, moderate energy carbon steel piping. The proposed alternative is based on ASME Code Case N-786 but contains certain aspects which deviate from the code case. The proposed alternative addresses the three repair options listed in the code case which are Type A sleeves, partial structural Type B sleeves, and full structural Type B sleeves.

ASME Code Case N-786 involves the application of Type A and Type B full encirclement sleeve halves welded together with full penetration longitudinal seam welds to reinforce structural integrity in the degraded area. In the case of Type B reinforcing sleeves, the ends are also welded to the piping in order to restore pressure integrity. The licensee stated that this repair technique will be utilized when it is determined that this repair method is suitable for the particular defect or degradation being resolved without flaw removal.

The licensee included a summary of its implementation of the code case with modifications. The licensee stated that ASME Code Case N-786 was approved by the ASME Board on Nuclear Codes and Standards on March 24, 2011; however, it has not been incorporated into NRC Regulatory Guide (RG) 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1."

The licensee stated that an alternative to use Code Case N-786 with modifications, similar to the current proposed alternative, was approved for the third 10-year ISI interval, which ended July 15, 2016, at Byron Station, Unit Nos. 1 and 2. In addition, the licensee noted that NRC Draft RG DG-1296, Proposed Revision 18 of RG 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," proposes to approve use of Code Case N-786 without conditions.

The licensee's proposed alternative to the requirements of ASME Code, Section XI, Paragraph IWA-4000, is to follow the requirements contained in ASME Code Case N-786 with modifications. The licensee's modifications to the code case are described below.

Section 1, "General Requirements"

In addition to the general requirements of the code case, the licensee's proposed alternative added the following limitation: "Reinforcing sleeves may not be applied to pumps, valves, expansion joints, vessels, heat exchanges, tubing, or flanges; and may not be applied over flanged joints, socket welded or threaded joints, or branch connection welds."

Section 2, "Initial Evaluation"

The licensee's alternative defines the inspection area to include at least $0.75\sqrt{Rtnom}$ (R and T are the radius and nominal thickness of the pipe, respectively) beyond the toe of the attachment weld.

Paragraph 2(b) of the code case states, in part, that the dimensions of the surrounding area to be evaluated shall be determined by the Owner, based on the type and rate of degradation present. The licensee's alternative modifies this paragraph by adding "Surrounding areas showing signs of degradation shall be identified and included in the Owner's plan for thickness monitoring for full-structural reinforcing sleeves."

Section 3 "Design"

The licensee's alternative includes additional requirements to those in the code case and states that the initial degradation rate selected for design of all sleeves shall be equal to or greater than two times the maximum rate observed at the location of the repair. If the degradation rate for that location is unknown, four times the estimated maximum degradation rate for that or a similar system at the same plant site for the same degradation mechanism shall be applied. If both the degradation rate for that location and the cause of the degradation are not conclusively determined, four times the maximum degradation rate observed for all degradation mechanisms for that or a similar system at the same plant site shall be applied.

The licensee's alternative includes a condition which states that branch connections may be installed on reinforcing sleeves only for filling or venting purposes during installation or leakage testing of the sleeve, and shall be limited to nominal pipe size (NPS) 1 or smaller in size.

Section 4, "Water-Backed Applications"

The licensee's alternative includes a modification to the code case requirements for water-backed applications which states that Type B reinforcing sleeves may be applied to leaking systems by installing a gasket or sealant between the sleeve and the pipe as permitted by the code case, and then clamping the reinforcing sleeve halves to the piping prior to welding. Residual moisture is then removed by heating prior to welding. If welding of any type of sleeve occurs on a wet surface, the maximum permitted life of the sleeve shall be the time until the next refueling outage.

Section 5, "Installation," Section 6, "Examination," and Section 7, "Pressure Testing"

The licensee's alternative did not contain any modifications that impact these portions of the code case.

Section 8, "Inservice Examination"

The licensee stated that the code case requires that the Owner shall prepare and implement a plan for thickness monitoring by inspection of full-structural reinforcing sleeves and their attachment welds. The licensee further stated that to accomplish this, a baseline thickness examination will be performed for completed full structural Type B reinforcing sleeves, partial penetration attachment welds, and surrounding areas, followed by similar thickness monitoring inspections performed at a minimum of every refueling outage for the life of the repair. More frequent thickness monitoring examinations will be scheduled based on the maximum degradation rates observed during these inspections such that the required design thicknesses will not be infringed upon before each subsequently scheduled thickness monitoring examination.

The licensee stated that partial structural Type B reinforcing sleeves and Type A reinforcing sleeves completely encompass the degraded areas and are designed to accommodate predicted maximum degradation and must be removed at the next refueling outage. The licensee noted that the code case does not require inservice monitoring for these sleeves. The licensee's alternative includes a modification to the code case which adds inservice monitoring and requires that Type A reinforcing sleeves and partial-structural Type B reinforcing sleeves shall be visually observed at least once per month to monitor for evidence of leakage. In addition, if the areas containing these sleeves are not accessible for direct observation, then monitoring will be accomplished by visual assessment of surrounding areas or ground surface areas above such sleeves on buried piping, or monitoring of leakage collection systems, if available.

3.1.5 Hardship Justification

The licensee stated that performing code repair/replacement in lieu of implementing its proposed alternative would in some case necessitate extending technical specification (TS)

actions to install a permanent repair/replacement, putting the plant at higher risks than warranted compared with the short time necessary to install a technically sound sleeve repair. The licensee further stated that without the proposed alternative, it may be necessary to shut down the plant in order to perform a code repair/replacement activity which results in an unnecessary plant transient and the loss of safety system availability as compared to maintaining the plant online.

3.1.6 Duration of Proposed Alternative

The licensee requested the proposed alternative for Byron Station, Unit Nos. 1 and 2, fourth 10-year ISI interval which began on July 16, 2016, and is scheduled to end on July 15, 2025. The licensee stated that when ASME Code Case N-786 is approved for use by the NRC and incorporated into RG 1.147, its alternative will no longer be required and the code case, including any RG 1.147 conditions, will be utilized in lieu of this alternative. Any Type A and partial structural Type B reinforcing sleeves installed before the end of the 10-year ISI interval will be removed during the next refueling outage, even if that refueling outage occurs after the end of the 10-year ISI interval.

3.2 NRC Staff Evaluation

Code Case N-786 provides an alternative to the ASME Code requirements in IWA-4400 for replacement or internal weld repair of ASME Class 2 and 3 moderate energy carbon steel piping systems. On March 2, 2016, the NRC published in the *Federal Register* (81 FR 10780) a proposed rule which, in part, would incorporate by reference into the NRC regulations the latest revision of RG 1.147, "Inservice Inspection code case Acceptability, ASME Code, Section XI, Division 1," Revision 18 (Draft RG DG-1296) (ADAMS Accession No. ML15027A202). As part of the proposed rule, the NRC staff proposed to endorse Code Case N-786 with no conditions (see DG-1296). The use of Code Case N-786 by nuclear power plants requires specific NRC approval until the final rule is issued.

Code Case N-786 provides three reinforcing sleeves options, Type A sleeve, partial structural and full structural Type B. The Type A sleeve may be used for structural reinforcement of thinned areas which are not expected to penetrate the wall and cause leakage. The partial structural Type B sleeves may be used for structural reinforcement of thinned areas that penetrate or are expected to penetrate the wall and cause leakage. Both Type A and Type B partial structural sleeves have a maximum service life of the time until the next refueling outage. Type A and Type B partial structural sleeves installed during a refueling outage have a maximum service life of one fuel cycle until the next refueling outage. Type B full structural sleeves are designed to accommodate pressure plus design loadings at the location of degradation for the design life of the repair.

An alternative to use Code Case N-786 with modifications, at Byron Station, Unit Nos. 1 and 2, was approved for the for the third 10-year ISI interval which ended July 15, 2016. The NRC's safety evaluation (SE) for the licensee's alternative to use Code Case N-786 for the third 10-year ISI interval is documented in a letter dated July 31, 2014 (ADAMS Accession No. ML14175B593). The current proposed alternative for the fourth ISI interval is similar to the licensee's previous proposed alternative for the third ISI interval. There has been no operational experience or other information presented to the NRC since it approved the

licensee's last request to use N-786 that would invalidate any elements of the staff's previous technical review of the code case for use at Byron Units 1 and 2. Therefore, the NRC staff's review of the current proposed alternative will focus on the licensee's modifications to the code case and its request under 10 CFR 50.55a(z)(2).

3.2.1 Evaluation of Licensee's Modifications to Code Case N-786

Section 1, "General Requirements"

The licensee stated that reinforcing sleeves may not be applied to pumps, valves, expansion joints, vessels, heat exchanges, tubing, or flanges and may not be applied over flanged joints, socket welded or threaded joints, or branch connection welds. The NRC staff notes that the code case is only intended to be used on piping. The licensee's modification provides clarity and ensures that the code case will not be used on components for which it was not intended. Therefore, the NRC staff finds this modification acceptable.

Section 2, "Initial Evaluation"

Paragraph 2(a) of the code case states that the material beneath the surface to which the reinforcing sleeve is to be applied shall be ultrasonically measured to establish the existing wall thickness and the extent and configuration of degradation to be reinforced. The code case further states that the adjacent area shall be examined to verify that the repair will encompass the entire unacceptable area, and that the adjacent base material is of sufficient thickness to accommodate the attachment welds at the edges of the sleeve. The licensee's alternative includes an additional requirement that the area of evaluation shall extend at least $0.75\sqrt{Rtnom}$ (R and T are the radius and nominal thickness of the pipe, respectively) beyond the toe of the attachment weld. The NRC staff finds this acceptable because the extension of the area of evaluation to $0.75\sqrt{Rtnom}$ beyond the attachment weld will ensure the area adjacent to the attachment weld is sufficient to support the repair.

Paragraph 2(b) of the code case states, "The cause and rate of degradation shall be determined. The extent and rate of degradation in the piping shall be evaluated to ensure that there will be no other unacceptable locations within the surrounding area that could affect the integrity of the reinforced areas for the life of the repair. The dimensions of the surrounding area to be evaluated shall be determined by the Owner, based on the type and rate of degradation present." The licensee's alternative modifies the requirement of paragraph 2(b) by adding that surrounding areas showing signs of degradation shall be identified and included in the Owner's plan for thickness monitoring for full structural reinforcing sleeves. The NRC staff notes that given that full-structural reinforcing sleeves may remain in service for several fuel cycles, it is prudent to include any degraded surrounding areas in the Owners thickness monitoring plan for installed full-structural sleeves to ensure that assumed degradation rates remain valid. The NRC staff, therefore, finds this acceptable.

Section 3, "Design"

Paragraph 3.2(k) of Code Case N-786 states that the predicted maximum degradation of the carrier base metal and reinforcing sleeve over the design life of the reinforcement shall be

based on in-situ inspection and established data for similar base metals. The licensee's alternative includes additional requirements and states that the initial degradation rate selected for design of all sleeves shall be equal to or greater than two times the maximum rate observed at the location of the repair. If the degradation rate for that location is unknown, four times the estimated maximum degradation rate for that or a similar system at the same plant site for the same degradation mechanism shall be applied. If both the degradation rate for that location and the cause of the degradation are not conclusively determined, four times the maximum degradation rate observed for all degradation mechanisms for that or a similar system at the same plant site shall be applied.

The NRC staff finds the above acceptable because applying a safety factor of either 2 or 4, as applicable, will provide a sufficiently conservative potential rate of degradation to ensure that the sleeves will perform their intended function until the next scheduled outage, at which time the sleeve is removed and the degraded pipe is permanently repaired (Type A and partial structural Type B) or receives a thickness monitoring inspection (full structural Type B).

The licensee's alternative includes a condition which states that branch connections may be installed on reinforcing sleeves only for filling or venting purposes during installation or leakage testing of the sleeve, and shall be limited to NPS 1 or smaller in size. The NRC staff notes that it may become necessary to install a small branch connection to a reinforcing sleeve and a maximum size of 1 NPS seems reasonable. In addition, any branch connection must meet the requirements of ASME Code Section III. The NRC staff, therefore, finds this acceptable.

Section 4, "Water-Backed Applications"

The licensee's alternative states that Type B reinforcing sleeves may be applied to leaking systems by installing a gasket or sealant between the sleeve and the pipe as permitted by the code case, and then clamping the reinforcing sleeve halves to the piping prior to welding. Residual moisture is then removed by heating prior to welding.

Welding on a wet surface can impact weld quality. The NRC staff finds that the above modification ensures that steps will be taken to remove moisture from the weld area and is, therefore, acceptable.

Section 8, "Inservice Examination"

Code Case N-786 includes requirements for inservice examination of Type B full structural sleeves. The code case requires that monitoring activities be performed during the first two refueling outages after installation, and at least every fourth refueling outage thereafter.

The licensee's alternative states that a baseline thickness examination will be performed for completed full-structural Type B reinforcing sleeves, partial penetration attachment welds, and surrounding areas, followed by similar thickness monitoring inspections performed at a minimum of every refueling outage for the life of the repair. The licensee will also perform more frequent examinations based on the maximum degradation rates observed during these inspections, if necessary, to ensure that the required design thicknesses will not be infringed upon before each subsequently scheduled thickness monitoring examination. The NRC staff finds this modification acceptable because more frequent examinations, than those required in

the code case, provides a higher level of assurance that the minimum required design thickness is maintained and that unanticipated increases in degradation rates will be identified so that corrective action can be taken.

The code case does not include inservice examinations for partial structural Type B or Type A reinforcing sleeves. The licensee's alternative includes a modification to the code case which requires that Type A reinforcing sleeves and partial structural Type B reinforcing sleeves shall be visually observed at least once per month to monitor for evidence of leakage. For partial structural Type B or Type A reinforcing sleeves that are inaccessible for direct observation, the licensee will perform visual assessment of surrounding areas or ground surface areas above such sleeves on buried piping, or monitoring of leakage collection systems, if available. The NRC staff notes that it is unlikely that partial structural Type B or Type A reinforcing sleeves installed in accordance with the code case would leak within one outage cycle, at which time they are removed from service. However, it is prudent to perform occasional direct visual examinations or visual assessment, as described by the licensee, to verify the leakage has not occurred. Therefore, the NRC staff finds this modification acceptable because it provides additional assurance that leak tightness and structural integrity of the partial structural Type B or Type A reinforcing sleeves will be maintained during the time they are inservice

3.2.2 Summary

The NRC staff finds that the proposed alternative will provide reasonable assurance of the structural integrity and leak tightness of repaired ASME Classes 2 and 3 moderate energy carbon piping systems. The NRC staff's finding is based on the above evaluation of the licensee's modifications when using Code Case N-786 and the NRC staff's previous SE for the licensee's alternative to use Code Case N-786 for the third 10-year ISI interval (ADAMS Accession No. ML14175B593).

3.2.3 Hardship Justification

Making permanent ASME Code compliant repairs of piping systems may require the system to be removed from service and the plant to shutdown. Additionally, performing the ASME Code repair during normal operation may challenge the technical specification completion time requirements and place the plant at higher safety risk than warranted. Therefore, the NRC staff determined that compliance with the specified ASME Code repair requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff determined that the proposed alternative provides reasonable assurance of structural integrity and leak tightness of the subject components and that complying with ASME Code, Section XI, IWA-4400, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the staff authorizes the use of the proposed alternative described in the licensee's April 15, 2016, letter, for the fourth 10-year ISI interval at Byron Station, Unit Nos. 1 and 2, or until the NRC approves Code Case N-786 for general use through rulemaking and revision to NRC RG 1.147, whichever comes first.

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

Principal Contributor: R. Davis, NRR/DE/EPNB

Date: December 20, 2016

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

Sincerely,

/RA/

David J. Wrona, Chief
Plant Licensing Branch 3
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos.: STN 50-454, STN 50-455

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