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

January 17, 2019

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: BRAIDWOOD STATION, UNITS 1 AND 2 – RELIEF FROM THE REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE (EPID L-2018-LLR-0034)

Dear Mr. Hanson:

By letter dated March 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18078A185), Exelon Generation Company, LLC (Exelon, the licensee), submitted relief request (RR) I4R-04 for the fourth 10-year inservice inspection (ISI) interval at Braidwood Station, Units 1 and 2 (Braidwood). The licensee requested to use 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). The proposed alternative would allow the licensee to use ASME Code Case N-513-4, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping Section XI, Division 1," for the evaluation and temporary acceptance of flaws in moderate energy Class 2 and Class 3 piping in lieu of specified ASME Code requirements for the fourth 10-year ISI interval.

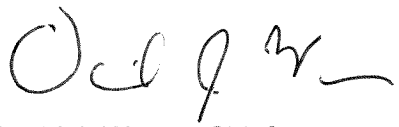
Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee requested to use the alternative on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that Exelon has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the staff authorizes the use of RR I4R-04 for the fourth ISI intervals at Braidwood, Units 1 and 2, which started on August 29, 2018, and on November 5, 2018, respectively, or until such time as the NRC approves Code Case N-513-4 for general use through revision of RG 1.147 or another document. By its letter dated March 19, 2018, the licensee indicated that the fourth ISI interval for Unit 2 was scheduled to start on October 17, 2018, but also indicated that the start was subject to the allowable changes for inspection intervals in IWA-2430. By letter dated October 4, 2018 (ADAMS Accession No. ML18284A445), the licensee indicated that the fourth inspection interval for Unit 2 was scheduled to start on November 5, 2018.

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

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

Sincerely,



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

Docket Nos. 50-456 and 50-457

Enclosure:
Safety Evaluation

cc:
Listserv

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST I4R-04 REGARDING EVALUATION AND TEMPORARY ACCEPTANCE OF FLAWS IN MODERATE ENERGY CLASS 2 AND 3 PIPING

EXELON GENERATION COMPANY, LLC

BRAIDWOOD STATION, UNITS 1 AND 2

DOCKET NOS. 50-456 AND 50-457

1.0 INTRODUCTION

By letter dated March 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18078A185), Exelon Generation Company, LLC (Exelon, the licensee), submitted relief request (RR) I4R-04 for the fourth 10-year inservice inspection (ISI) interval at Braidwood Station, Units 1 and 2 (Braidwood). The licensee requested to use 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). The proposed alternative would allow the licensee to use ASME Code Case N-513-4, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping Section XI, Division 1," for the evaluation and temporary acceptance of flaws in moderate energy Class 2 and 3 piping in lieu of specified ASME Code requirements for the fourth 10-year ISI interval.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee requested to use the 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.

2.0 REGULATORY EVALUATION

The licensee proposes an alternative to the requirement of ASME Code, Section XI, Articles IWC-3000 and IWD-3000.

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 U.S Nuclear Regulatory Commission (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 ASME Code Components

The affected components are ASME Code, Class 2 and 3, moderate energy piping systems, as described in Code Case N-513-4, Section 1, "Scope," whose maximum operating temperature does not exceed 200 degrees Fahrenheit and whose operating pressure does not exceed 275 pounds per square inch gauge.

3.2 Applicable ASME Code Requirements

The code of record for the fourth 10-year ISI interval at Braidwood is the ASME Code, Section XI, 2013 Edition. ASME Code, Section XI, Articles IWC-3120 and IWD-3120, require that flaws exceeding the defined acceptance criteria be corrected by repair/replacement activities or evaluated and accepted by analytical evaluation. ASME Code, Section XI, Articles IWC-3130 and IWD-3130, require that relevant conditions be subject to supplemental examination, corrective measures or repair/replacement activities, or evaluated and accepted by analytical evaluation.

3.3 Proposed Alternative and Basis for Use

The licensee's proposed alternative is to use ASME Code Case N-513-4 for the evaluation and temporary acceptance of flaws in moderate energy Class 2 and 3 piping in lieu of specified ASME Code, Section XI, requirements. In addition, the licensee's proposed alternative includes the determination of an allowable leakage rate by dividing the critical leakage rate by a safety factor of four.

The licensee stated that limitations in Code Case N-513-3, related to its use on piping components such as elbows, bent pipe, reducers, expanders, branch tees, and external tubing or piping attached to heat exchangers, have been addressed in Code Case N-513-4. The licensee provided a high level overview of the differences between Code Case N-513-3 and Code Case N-513-4 as listed below:

1. Revised the maximum allowable time of use from no longer than 26 months to the next refueling outage.

2. Added applicability to piping elbows, bent pipe, reducers, expanders, and branch tees where the flaw is located more than $(R_0t)^{1/2}$ from the centerline of the attaching circumferential piping weld.

3. Expanded use to external tubing or piping attached to heat exchangers.

4. Revised to limit the use to liquid systems.

5. Revised to clarify treatment of service level load combinations.

6. Revised to address treatment of flaws in austenitic pipe flux welds.

7. Revised to require minimum wall thickness acceptance criteria to consider longitudinal stress in addition to hoop stress.

8. Other minor editorial changes to improve the clarity of the code case

As part of a previous NRC-approved alternative dated September 6, 2016 (ADAMS Accession No. ML16230A237), for the Exelon fleet of nuclear power plants request to use Code Case N-513-4 dated January 28, 2016 (ADAMS Accession No. ML 16029A003), the licensee provided a technical basis document for the fourth revision to N-513 entitled "Proceedings of the ASME 2014 Pressure Vessels & Piping Conference, PVP2014, July 20-24, 2014, Anaheim, California, USA, PVP2014-28355, 'Technical Basis for Proposed Fourth Revision to ASME Code Case N-513. '" The licensee referenced the information provided in its previous alternative request as being applicable to its current proposed alternative.

The licensee stated that the effects of leakage may impact the operability determination or the plant flooding analyses specified in paragraph 1(f) of Code Case N-513-4. For a leaking flaw, the licensee stated that the allowable leakage rate will be determined by dividing the critical leakage rate by a safety factor of four. The critical leakage rate is determined as the limiting leakage rate that can be tolerated and may be based on the allowable loss of inventory or the maximum leakage that can be tolerated relative to room flooding, among others. The licensee contends that applying a safety factor of four to the critical leakage rate provides quantitative measurable limits which ensure the operability of the system and early identification of issues that could erode defense-in-depth and lead to adverse consequences.

The licensee stated that Code Case N-513-4 utilizes technical evaluation approaches that are based on principles that are accepted in other code documents already acceptable to the NRC. The licensee also stated that application, in concert with safety factors on leakage limits, will maintain acceptable structural and leakage integrity while minimizing plant risk and personnel exposure by minimizing the number of plant transients that could be incurred if degradation is required to be repaired based on ASME Code, Section XI, acceptance criteria only.

3.4 Hardship Justification

As stated by the licensee, moderately degraded piping could require a plant shutdown within the required action statement timeframes in the plant technical specifications to repair observed degradation. Plant shutdown activities result in additional dose and plant risk that would be inappropriate when a degraded condition is demonstrated to retain adequate margin to complete the component's function. The licensee contends that use of an acceptable alternative analysis method in lieu of immediate action for a degraded condition will allow it to perform additional extent of condition examinations on the affected systems while allowing time for safe and orderly long term repair actions if necessary. Actions to remove degraded piping from service could have a detrimental overall risk impact by requiring a plant shutdown, thus requiring use of a system that is in standby during normal operation. The licensee believes that compliance with the current code requirements results in a hardship without a compensating increase in the level of quality and safety.

3.5 Duration of Proposed Alternative

The licensee stated that the duration of the proposed alternative is the fourth 10-year ISI interval at Braidwood or such time as the NRC approves Code Case N-513-4 in Regulatory Guide (RG) 1.147 or other document. The licensee stated that if a flaw is evaluated near the end of the interval, and the next refueling outage is in the subsequent interval, the flaw may remain in service until the next refueling outage.

3.6 NRC Staff Evaluation

The NRC staff evaluated the adequacy of the proposed alternative in maintaining the structural integrity of piping components identified in Code Case N-513-4. Code Case N-513-3, which is conditionally approved for use in RG 1.147, provides alternative evaluation criteria for temporary acceptance of flaws including through-wall flaws, in moderate energy Class 2 and 3 piping. However, Code Case N-513-3 contains limitations that the licensee considers restrictive and could result in an ASME Code repair that leads to an unnecessary plant shutdown. Code Case N-513-3 is limited to straight pipe with provisions for flaws that extend for a short distance into the fitting. Evaluation criteria for flaws in elbows, bent pipe, reducers, expanders, branch tees, and heat exchangers, are not included within the scope of N-513-3 as Code Case N-513-4 addresses these aforementioned limitations. Given that Code Case N-513-3 is conditionally approved for use in RG 1.147, Revision 18, the staff focused its review on the differences between Code Cases N-513-3 and N-513-4. The significant changes in N-513-4 include: (1) revised temporary acceptance period; (2) added flaw evaluation criteria for elbows, bent pipe, reducers/expanders and branch tees; (3) expanded applicability to heat exchanger tubing or piping; (4) limited use to liquid systems; (5) clarified treatment of service load combinations; (6) revised treatment of flaws in austenitic pipe flux welds; (7) revised minimum wall thickness acceptance criteria to consider longitudinal stress in addition to hoop stress; and (8) revised leakage monitoring requirements. The NRC staff also evaluated the licensee's proposed limitation on the leakage rate and its hardship justification.

The NRC staff notes that many requirements specified in Code Case N-513-4 are not discussed in this safety evaluation (SE) but they should not be considered as less important. As part of the NRC-approved proposed alternative, all requirements must be followed. Any exceptions or restrictions to the code case that are approved in this SE also need to be followed.

3.6.1 Temporary Acceptance Period

Code Case N-513-3 specifies a temporary acceptance period of a maximum of 26 months and is accepted for use in RG 1.147, Revision 18, with the following condition - "The repair or replacement activity temporarily deferred under the provisions of this code case shall be performed during the next scheduled outage." Code Case N-513-4 includes wording that limits the use to the next refueling outage. The NRC staff finds that Code Case N-513-4 appropriately addresses the condition on Code Case N-513-3 and is, therefore, acceptable. In addition, the NRC staff finds acceptable the licensee's statement that if a flaw is evaluated near the end of the ISI interval, and the next refueling outage is in the subsequent interval, the flaw may remain in service until the next refueling outage.

3.6.2 Flaw Evaluation Criteria for Elbows, Bent Pipe, Reducers/Expanders, and Branch Tees.

Evaluation and acceptance criteria have been added to Code Case N-513-4 for flaws in elbows, bent pipe, reducers, expanders, and branch tees using a simplified approach which is based on the Second International Piping Integrity Research Group (IPIRG-2) program reported in NUREG/CR-6444 BMI-2192, "Fracture Behavior of Circumferentially Surface-cracked Elbows," October 1993-March 1996, published December 1996.

The flaw evaluation methodology approach in Code Case N-513-4 for piping components is conducted as if in straight pipe by scaling hoop and axial stresses using ASME Code piping design code stress indices and stress intensification factors to account for the stress variations caused by the geometric differences. Equations used in the code case are consistent with the piping design by rule approach in ASME Code, Section III, NC/ND-3600. NUREG/CR-6444 shows that this approach is conservative for calculating stresses used in flaw evaluations in piping elbows and bent pipe. The code case also applies this methodology.

The NRC staff finds that the flaw evaluation and acceptance criteria in Code Case N-513-4 for elbows, bent pipe, reducers, expanders and branch tees is acceptable and are consistent with ASME Code, Sections XI and III design by rule approach and provides a conservative approach as confirmed by comparing the failure moments predicted using this approach to the measured failure moments from the elbow tests for through-wall circumferential flaws conducted as part of the IPIRG-2 program.

3.6.3 Flaw Evaluation in Heat Exchanger Tubing or Piping

Code Case N-513-4 has been revised to include heat exchanger external tubing or piping provided that the flaw is characterized in accordance with Section 2(a) and leakage is monitored. Section 2(a) requires that the flaw geometry be characterized by volumetric inspection or physical measurement.

The NRC staff determined that the flaw evaluation criteria in Code Case N-513-4 for straight or bent piping, as appropriate, can be applied to heat exchanger external tubing or piping. The staff determined the methods for evaluating flaws in straight pipe are acceptable and are currently allowed in Code Case N-513-3. For bent pipe, the acceptability is described in Section 3.2.2 above. Therefore, the NRC staff finds inclusion of heat exchanger external tubing or piping in the code case to be acceptable.

3.6.4 Limit Use to Liquid Systems

Use of Code Case N-513-4 is specifically limited to liquid systems. The NRC staff finds this change acceptable since Code Case N-513-4 is not intended to apply to air or other compressible fluid systems.

3.6.5 Treatment of Service Load Combinations

Modifications in N-513-4 now make clear that all service load combinations must be considered in flaw evaluations to determine the most limiting condition, although previously implied in N-513-3, N-513-4 makes this requirement clear. Therefore, the NRC staff finds this change acceptable.

3.6.6 Treatment of flaws in austenitic pipe flux welds

Paragraph 3.1(b) of Code Case N-513-4 contains modifications which include a reference to ASME Code, Section XI, Appendix C, C-6320, to address flaws in austenitic stainless steel pipe flux welds. The ASME Code, Section XI, Appendix C, C-6000, permits the use of elastic plastic fracture mechanics criteria in lieu of limit load criteria to analyze flaws in stainless steel pipe flux welds. Equation 1 of the code case was also revised to be consistent with ASME Code, Section XI, Appendix C, C-6320, so the equation can be used for flaws in austenitic stainless steel pipe flux welds. The NRC staff finds this acceptable because it is consistent with the ASME Code sections referenced above.

3.6.7 Minimum Wall Thickness Acceptance Criteria to Consider Longitudinal Stress

Previous versions of the code case only required the use of hoop stress. Although it is unlikely that a longitudinal stress based minimum wall thickness would be limiting when compared to a hoop stress based minimum wall thickness, Code Case N-513-4 includes revisions that require consideration of longitudinal stress in the calculation of minimum wall thickness. The NRC staff finds this acceptable because including this consideration is more conservative.

3.6.8 Leakage Monitoring for Through-Wall Flaws

Code Case N-513-3 required through-wall leakage to be observed by daily walkdowns to confirm the analysis conditions used in the flaw evaluation remain valid. Code Case N-513-4 modifies this requirement by continuing to require that leakage be monitored daily but now allows other techniques to be used to monitor leakage such as using visual equipment or leakage detection systems to determine if leakage rates are changing. The NRC staff finds this change acceptable because the other allowed techniques are as effective as daily walkdowns. The code case continues to require through-wall leaks to be monitored daily and inspected every 30 days.

3.6.9 Leakage Rate

Code Case N-513-3, paragraph 1(d), states, "The provisions of this code case demonstrate the integrity of the item and not the consequences of leakage. It is the responsibility of the Owner to demonstrate system operability considering effects of leakage." Code Case N-513-4 modified the last sentence, now located in paragraph (f), to state, "It is the responsibility of the Owner to consider effects of leakage in demonstrating system operability and performing plant flooding analyses."

The licensee stated that the allowable leakage rate will be determined by dividing the critical leakage rate by a safety factor of four. The critical leakage rate is determined as the limiting leakage rate that can be tolerated and may be based on the allowable loss of inventory or the maximum leakage that can be tolerated relative to room flooding, among others. The licensee contends that applying a safety factor of four to the critical leakage rate provides quantitative measurable limits which ensure the operability of the system and early identification of issues that could erode defense-in-depth and lead to adverse consequences.

Code Cases N-513-3 and N-513-4 do not contain leakage limits for components with through-wall flaws. The NRC staff finds that the licensee's approach of applying a safety factor of four to the critical leakage rate is acceptable because this provides a leakage limit with margin to the critical leakage rate.

3.6.10 Hardship Justification

The NRC staff finds that performing a plant shutdown to repair the subject piping would cycle the unit and increase the potential of an unnecessary transient resulting in undue hardship. Additionally, performing certain ASME Code repair during normal operation would challenge the technical specification completion time and place the plant at higher safety risk than warranted. Therefore, the 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.

3.7 Summary

The NRC staff finds that the proposed alternative will provide reasonable assurance of the structural integrity because: (1) Code Case N-513-4 addresses the NRC condition in RG 1.147, Revision 18, for N-513-3; (2) flaw evaluations in component types added to N-513-4 are based on acceptable methodologies; and (3) the method for determining the allowable leakage rate is adequate to provide early identification of a significant increase in leakage. In addition, complying with ASME Code, Section XI requirement 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 of the subject components and that complying with Articles IWC-3120, IWC-3130, IWD-3120, and IWD-3130, of the ASME Code, Section XI, would result in a 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 NRC staff authorizes the use of the licensee's proposed alternative RR I4R-04, as described in its March 19, 2018, application, to use ASME Code Case N-513-4 at Braidwood for the respective fourth 10-year ISI interval identified in Section 3.1.2 of this SE, or until such time as the NRC approves Code Case N-513-4 for general use through revision of RG 1.147 or another document.

If the proposed alternative is applied to a flaw near the end of the authorized 10-year ISI interval and the next refueling outage is in the subsequent interval, the licensee is authorized to continue to apply the proposed alternative to the flaw until the next refueling outage. The NRC staff notes that approval of this alternative does not imply or infer NRC approval of ASME Code Case N-513-4 for generic use.

All other requirements of the ASME Code, Section XI, for which relief has not been specifically requested and authorized by NRC staff remain applicable, including a third-party review by the Authorized Nuclear In-service Inspector.

Principal Contributor: R. Davis

Date of issuance: January 17, 2019

SUBJECT: BRAIDWOOD STATION, UNITS 1 AND 2 – RELIEF FROM THE REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS CODE (EPID L-2018-LLR-0034) DATED JANUARY 17, 2019

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