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-0031)

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 I4R-01 for the fourth 10-year inservice inspection (ISI) interval at Braidwood Station Units 1 and 2 (Braidwood). The licensee's request for relief is to continue applying their previous risk-informed inservice inspection (RI-ISI) program utilizing the Electric Power Research Institute's (EPRI's) Topical Report (TR) 112657, Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," December 1999 (ADAMS Accession No. ML013470102), for certain Class 1 and Class 2 piping welds during the fourth 10-year ISI interval in lieu of the requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Tables IWB-2500-1 and IWC-2500-1.

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 the alternative provides an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC or Commission) 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)(1). Therefore, the NRC staff authorizes the use of relief request I4R-01 for the fourth ISI intervals at Braidwood, Units 1 and 2, which started on August 29, 2018, and on November 5, 2018, respectively. 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

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST I4R-01 REGARDING RISK INFORMED

INSERVICE INSPECTION PROGRAM

EXELON GENERATION COMPANY, LLC

BRAIDWOOD STATION, UNITS 1 AND 2

DOCKET NOS. 50-456 AND 50-457

1.0 INTRODUCTION

By application dated May 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18078A185), the Exelon Generation Company, LLC (Exelon, the licensee) submitted relief request (RR) I4R-01 for the fourth 10-year inservice inspection (ISI) interval at Braidwood Station (Braidwood), Units 1 and 2. The licensee requested to continue applying their previous risk-informed inservice inspection (RI-ISI) program utilizing the Electric Power Research Institute's (EPRI's) Topical Report (TR)-112657, Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," December 1999 (ADAMS Accession No. ML013470102), for certain Class 1 and Class 2 piping welds during the fourth 10-year ISI interval in lieu of the requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Tables IWB-2500-1 and IWC-2500-1.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(z)(1), the licensee requested to use a proposed alternative on the basis that the proposed alternative would provide an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

Regulation 10 CFR 50.55a(g), requires that ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, "except design and access provisions and pre-service examination requirements," set forth in the ASME Code to the extent practical within the limitations of the design, geometry, and materials of construction of the components. 10 CFR 50.55a(g) of also states that ISI of the ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable addenda, except where specific written relief has been granted by the NRC.

Regulation 10 CFR 50.55a(g)(4), requires that during the first 10-year ISI interval and during subsequent intervals, the licensee's ISI program to comply with the requirements in the latest edition and addenda of the ASME Code incorporated by reference into 10 CFR 50.55a(b) 12 months before the start of the 120-month inspection interval subject to the conditions listed in 10 CFR 50.55a(b).

Pursuant to 10 CFR 50.55a(z), *Alternatives to Codes and Standards Requirements,* alternatives to the requirements of paragraphs (b) through (h) of 50.55a or portions thereof may be used when authorized by the Director, Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that: (1) *Acceptable Level of Quality and Safety*, the proposed alternative would provide an acceptable level of quality and safety; or (2) *Hardship without a Compensating Increase in Quality and Safety,* compliance with the specified requirements of 50.55a would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(z)(1), the licensee requested approval to continue use of its RI-ISI program as an alternative to the requirements of 10 CFR 50.55a during the fourth 10-year ISI interval at Braidwood, Units 1 and 2, on the basis that the proposed alternative would provide an acceptable level of quality and safety.

Based on the above, and subject to the following technical evaluation, the U.S. Nuclear Regulatory Commission (NRC or Commission) staff finds that regulatory authority exists for the licensee to request and the NRC to authorize the alternative requested by the licensee.

Regulation 10 CFR 50.55a(g) requires that a certain percentage of ASME Code Categories B-F, B-J, C-F-1, and C-F-2, pressure retaining piping welds must receive ISI during each 10-year ISI interval.

The ASME Code specifies that 100 percent of B-F welds and 25 percent of B-J welds greater than 1-inch nominal pipe size be selected for volumetric or surface examination, or both, on the basis of existing stress analyses. For Categories C-F-1 and C-F-2 piping welds, 7.5 percent of non-exempt welds are selected for volumetric or surface examination, or both. As discussed above, the NRC may authorize alternatives to the requirements of 10 CFR 50.55a(g).

The NRC staff evaluated the proposed RI-ISI programs using the following guidance documents:

- Regulatory Guide (RG) 1.174, Revision 2, "An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis [LB]" (ADAMS Accession No. ML100910006). RG 1.174 provides guidance on the use of probabilistic risk assessment (PRA) findings and risk insights in support of licensee requests for changes to a plant's LB. RG 1.174 also defines an acceptable approach to analyzing and evaluating proposed LB changes. The approach includes traditional engineering evaluations supported by insights derived from the use of PRA methods about the risk significance of the proposed changes. In implementing risk-informed decision making, the NRC expects LB changes to meet the acceptance guidelines and key principles of risk-informed regulation specified in RG 1.174;

- RG 1.178, Revision 1, "An Approach for Plant-Specific Risk-Informed Decision making – In-service Inspection of Piping" (ADAMS Accession No. ML032510128). RG 1.178 describes a RI-ISI program as one that incorporates risk-insights that can focus inspections on more important locations while at the same time maintaining or improving public health and safety;

- RG 1.200, Revision 1, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities" (ADAMS Accession

No. ML090410014). RG 1.200 describes one acceptable approach for determining whether the quality of the PRA, in total or the parts that are used to support an application, is sufficient to provide confidence in the results such that the PRA can be used in regulatory decision-making;

- NUREG-0800, Chapter 3.9.8, "Standard Review Plan for the Review of Risk-Informed In-service Inspection of Piping" (SRP 3.9.8) (ADAMS Accession No. ML032510135). SRP 3.9.8 describes review procedures and acceptance guidelines for NRC staff reviews of proposed plant-specific, risk-informed changes to a licensee's ISI program for piping, and;

- EPRI TR-112657, "Revised Risk-Informed Inservice Inspection Evaluation Procedure," Revision B-A (ADAMS Accession No. ML013470102).

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components

Class 1 and Class 2 pressure retaining piping welds subject to the requirements of ASME Code Section XI, Table IWB-2500-1 (Examination Categories B-F and B-J), and Table IWC-2500-1 (Examination Categories C-F-1 and C-F-2).

3.2 Applicable ASME Code Requirements

The selection of ASME Code Classes 1 and 2 pipe welds to be examined in the fourth inspection interval is required to be prescriptively determined in accordance with Table IWB-2500-1, Examination Categories B-F and B-J, and Table IWC-2500-1, Examination Categories C-F-1 and C-F-2. The code of record for Braidwood, Unit 1 and 2's, fourth 10-year ISI interval is the 2013 edition of the ASME Code, Section XI.

3.3 Proposed Alternative and Basis for Use

As an alternative to the ASME Code requirement, a risk-informed process will continue to be used for selection of Class 1 and Class 2 piping welds for examination.

The licensee proposes to continue applying the previous NRC-approved RI-ISI program as an alternative to the requirements of ASME Code, Section XI, Table IWB-2500-1 for Examination Categories B-F and B-J, and Table IWC-2500-1 for Examination Categories C-F-1 and C-F-2 during the fourth 10-year interval at Braidwood, Units 1 and 2.

The licensee stated that its fourth 10-year RI-ISI program would continue to follow the NRC staff approved methodology of RI-ISI criteria of EPRI TR-112657, Revision B-A, with two enhancements from ASME Code Case N-587-1, "Risk-Informed Requirements for Class 1, 2 or 3 Piping, Method B, Section XI, Division 1." The same methodology was used for the prior ISI interval. The licensee further stated that the initial RI-ISI program included a requirement for periodic reviews and updates due to significant changes, including relevant plant or industry feedback to appropriately identify safety significant piping locations. However, the licensee notes that, with the exception of specific weld locations that may have changed due to maintenance or modification activities (e.g., Fukushima FLEX modification) and the addition of

an Alloy 600 Augmented Examination Program, the proposed alternative RI-ISI program for the fourth ISI interval is the same program methodology as approved by the NRC for the third ISI interval.

3.4 Duration of Proposed Alternative

The alternative will be used for Braidwood until the end of each unit's fourth 10-year ISI interval. The Braidwood fourth 10-year ISI interval is currently scheduled to end on August 29, 2028, for Unit 1 and November 5, 2028, for Unit 2, subject to the allowable changes for inspection intervals in IWA-2430.

3.5 NRC Staff Evaluation

The licensee's proposed RI-ISI program was developed using the methodology described in the EPRI TR-112657, Revision B-A (ADAMS Accession No. ML013470102). The NRC staff's safety evaluation report (SER), included in the above document, approved the methodology described in the EPRI TR-112657, Revision B-A, with two enhancements from ASME Code Case N-587-1. The SER concluded that the methodology conforms to guidance provided in RG 1.174 and RG 1.178, and that no significant risk increase should be expected from the changes to the RI-ISI program resulting from applying this methodology.

The NRC staff has reviewed and evaluated the licensee's proposed RI-ISI program, including those portions related to the applicable methodology and processes, based on guidance and acceptance criteria provided in RG 1.174, RG 1.178, and SRP Chapter 3.9.8. An acceptable RI-ISI program plan is expected to meet the five key principles discussed in RG 1.178, SRP Chapter 3.9.8, and EPRI TR 112657, Revision B-A, as stated below:

1. The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change.

2. The proposed change is consistent with the defense-in-depth philosophy.

3. The proposed change maintains sufficient safety margins.

4. When proposed changes result in an increase in core damage frequency (CDF) or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.

5. The impact of the proposed change should be monitored by using performance measurement strategies.

Principle 1

The NRC staff reviewed the licensee's proposed alternative to verify that it meets the first principle. The NRC staff notes that the first principle is met in this proposed alternative because an alternative ISI program may be authorized pursuant to 10 CFR 50.55a(z)(1) and, therefore, an exemption request is not required.

Principles 2 and 3

The NRC staff reviewed the licensee's proposed alternative to verify that it meets the second and third principles. These principles require assurance that the alternative program is consistent with the defense-in-depth philosophy and that sufficient safety margins are maintained. The second and third principles are met because (a) the inservice inspection is an integral part of defense-in-depth; (b) as part of the RI-ISI process, the risk significance categorization and specification of the number and location for inspections will maintain the intent of ISI (i.e., identifying and repairing flaws before pipe integrity is challenged); and (c) the RI-ISI process does not affect the adequacy of design basis accident evaluations such that sufficient safety margins will be maintained.

Principle 4

The fourth key principle requires an evaluation of the estimated change in risk between the proposed RI-ISI program and the program the licensee would otherwise be required to implement. The change in risk estimate is dependent on the location of inspections in the proposed RI-ISI program compared to the location of inspections that would be performed using the deterministic requirements of the ASME Code, Section XI. In accordance with 10 CFR 50.55a, it is not necessary for the licensee to develop a new deterministic ASME Code program for each new 10-year ISI interval. The NRC staff compared the new proposed RI-ISI program with the last deterministic ASME Code program.

Risk Metrics

In its letter dated March 19, 2018, the licensee stated that for Braidwood, Unit 1, the change in CDF is 7.71E-08/year and the change in large early release frequency (LERF) is 1.53E-08/year. For Braidwood, Unit 2, the change in CDF is 6.85E-08/year and the change in LERF is 1.37E-08/year. These values are well below the "very small" change in CDF guideline of 1E-6/year and change in LERF of 1.00E-07/year specified in RG 1.174. These values also meet the acceptance guidelines in EPRI TR-112657.

Technical Acceptability of PRA

The fourth key principle requires demonstration of the technical adequacy of the licensee's PRA. As discussed in RGs 1.178 and 1.200, an acceptable change in risk evaluation (and risk-ranking evaluation used to identify the most risk signification locations) requires the use of a PRA of appropriate technical adequacy that models the as-built and as-operated plant. EPRI TR-1021467-A, "Nondestructive Evaluation: Probabilistic Risk Assessment Technical Adequacy Guidance for Risk-Informed In-Service Inspection Programs," provides guidance on the minimum acceptable quality requirement for a PRA used to support a risk-informed ISI program.

In its letter dated March 19, 2018, the licensee identified that the Braidwood PRA model received a peer review in July 2013 for internal events and flooding. The licensee also identified that an update of the Braidwood PRA model was completed in March 2017. The licensee stated that the model was subjected to a finding-level Facts and Observations (F&Os) peer review in February 2017 to perform an independent assessment of the close-out of record from the 2013 peer review. As a result of the closure of F&Os during this review, all supporting requirements (SRs) are now considered as Met at Capability Category (CC) II or higher. The methodology in EPRI TR-1021467-A states that not all SRs are required to meet CC II to adequately support RI-ISI applications (some specific SRs can meet CC I), and RG 1.200

considers it a good practice for all SRs to meet CC II. Since the Braidwood PRA meets all SRs at CC II and higher, the NRC staff finds that the licensee has assessed the technical adequacy of its PRA using the guidelines of RG 1.200, and the licensee's PRA is consistent with quality guidelines in EPRI TR-1021467-A.

Key Principle 4 Conclusions

The NRC staff finds the impact on CDF and LERF due to the implementation of the RI-ISI program satisfies the acceptance guidelines specified in RG 1.174 and EPRI TR-112657. The NRC staff also finds that the licensee has assessed the technical adequacy of its PRA using RG 1.200, Revision 2, and the PRA is consistent with the quality guidelines in EPRI TR-1021467-A. Therefore, the NRC staff finds that key principle 4 is met.

Principle 5

The NRC staff reviewed the licensee's proposed alternative to verify that it meets the fifth principle. The fifth principle of risk-informed decision making requires that the impact of the proposed change be monitored by using performance measurement strategies. As described in the RR, the RI-ISI program is a living program that requires periodic updating and that as a minimum, risk ranking of piping segments will be reviewed on an ASME Code period basis. In its submittal, the licensee stated that as part of its ISI program update for the fourth 10-year ISI interval, it assessed that the update in ASME Code from the 2001 Edition through the 2003 Addenda to the 2013 Edition of ASME Code, Section XI, did not impact the previously NRC-approved RI-ISI evaluation method and process. However, the licensee did note that changes would occur due to maintenance or modification activities (e.g., Fukushima FLEX modification) and the addition of an Alloy 600 Augmented Examination Program. Further, the licensee stated that the actual "evaluation and ranking" procedure remain unchanged and are continually applied to maintain the Risk Categorization and Element Selection methods of EPRI TR-112657, Revision B-A. Finally, the licensee concluded that these elements of the RI-ISI program have been, and will continue to be reevaluated and revised as major revisions of the site probabilistic risk assessment occur and modifications to plant configuration are made.

The NRC staff evaluated the licensee's statements and found the licensee had provided a sufficient basis for a living program by including consideration of plant-specific examination results, PRA updates, piping failures and changes, as well as industry piping failures.

The NRC staff notes the following specific examples of how the licensee has a living program. The licensee explained that Alloy 600/82/182 piping structural elements potentially subject to primary water stress corrosion cracking (PWSCC) with two different mitigation methods would be treated differently utilizing the Braidwood Alloy 600 Augmented Examination Program under ASME Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR [pressurized-water reactor] Piping and Vessel Nozzle Butt Welds Fabricated with UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities Section XI, Division 1," June 9, 2011, as conditioned in 10 CFR 50.55a(g)(6)(ii)(F).

- For welds in which full structural weld overlay (FSWOL) was applied, the welds were removed from the RI-ISI program and examined in accordance to N-770-2. This change is consistent with NRC expectations for the implementation of the augmented ISI requirements of 10 CFR 50.55a(g)(6)(ii)(F) for these welds. The volumetric inspection requirements for these welds under these requirements is a 25 percent sample each ISI interval, which is

greater than the analysis under EPRI TR-112657, Revision B-A would recommend. Therefore, the NRC staff finds the licensee's implementation of this program is adequate and provides reasonable assurance of structural integrity for these welds.

- For welds which were mitigated with a mechanical stress improvement process (MSIP), the licensee stated that these welds would remain in the RI-ISI Program and would also be addressed under the Braidwood Station Alloy 600 Augmented Examination Program under N-770-2. This change is consistent with NRC expectations for the implementation of the augmented ISI requirements of 10 CFR 50.55a(g)(6)(ii)(F) for these welds. However, by including these welds within the RI-ISI program, there is the potential that the inspection of these welds, under other requirements, could diminish the sample size of the weld population outside of those mitigated with MSIP. As noted by the licensee, the FSWOL mitigated welds were not included in the population for RI-ISI. However, the NRC staff notes that the volumetric inspection area of a FSWOL weld is different than a non-mitigated weld. Therefore, the inspection would not be able to identify other forms of degradation similarly as the volumetric examination of other non-mitigated welds. The NRC staff found this position acceptable for exclusion of the FSWOL welds. Since the volumetric inspection volume of the MSIP mitigated welds is the same as a non-mitigated weld, the volumetric inspection of MSIP welds could similarly identify other degradation mechanisms through their volumetric examination as other non-mitigated welds. As the MSIP mitigation process puts the wetted surface of a weld in compression, initiation of PWSCC flaws is not likely. Therefore, the NRC finds that if a weld, mitigated by MSIP, is found to be in a population for an additional degradation mechanism, it can be included in the total sample population for that category, since the volumetric inspection volume is the same as a non-mitigated weld.

Based on the examples reviewed by the NRC, the staff finds the licensee's implementation of the Braidwood Alloy 600 Augmented Examination Program within the licensee's proposed RI-ISI program is adequate and provides reasonable assurance of structural integrity of the subject systems and components.

The NRC finds that the analyses and updates identified by the licensee in its submittal demonstrate that the Braidwood RI-ISI program is a living program that is being periodically updated. In addition, all of the subject welds will continue to be subject to system leakage testing in accordance with ASME Code, Section XI. Therefore, the NRC staff concludes that the fifth key principle, which provides that risk-informed applications should include performance monitoring and feedback provisions, is met.

3.6 Results of the NRC Staff Evaluation

Based on the above discussion, the NRC staff finds that the five key principles of risk-informed decision making are met by the licensee's proposed use of RI-ISI program described in I4R-01. Therefore, the staff concludes that RG 1.178, SRP Chapter 3.9.8, and EPRI TR-112657, Revision B-A, are met. The NRC staff concludes that the proposed RI-ISI program for the fourth 10-year ISI interval at Braidwood is acceptable and provides an acceptable level of quality and safety.

4.0 CONCLUSION

Based on the NRC staff's findings set forth above, that the key principles included in RG 1.178, SRP Chapter 3.9.8, and EPRI TR 112657, Revision B-A are met, the NRC staff concludes that proposed alternative I4R-01 provides an acceptable 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)(1). Therefore, the NRC staff authorizes the use of relief request I4R-01 for the fourth ISI intervals at Braidwood, Units 1 and 2, which started on August 29, 2018, and on November 5, 2018, respectively. 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 ASME Code, Section XI, requirements for which relief was not specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributors: C. Spore
J. Collins

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-0031) DATED JANUARY 17, 2019

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