



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

October 15, 2015

Mr. Mark Kanavos
Site Vice President
Exelon Generation Company, LLC
Braidwood Station
35100 S. Rt. 53, Suite 84
Braceville, IL 60407

SUBJECT: BRAIDWOOD STATION, UNIT NOS. 1 AND 2 – PRESSURE AND
TEMPERATURE LIMITS REPORT FOR MEASUREMENT UNCERTAINTY
RECAPTURE POWER UPRATE (TAC NOS. MF3552 AND MF3553)

Dear Mr. Kanavos:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated February 28, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14059A124), Exelon Generation Company, LLC (the licensee) submitted the pressure and temperature limits report for measurement uncertainty recapture power uprate, for the Braidwood Station, Units 1 and 2, as required by technical specification 5.6.6. By letter dated February 27, 2015 (ADAMS Accession No. ML15058A773), the licensee supplemented the submittal in response to the NRC staff's request for additional information by e-mail dated January 29, 2015 (ADAMS Accession No. ML15030A007).

The NRC staff has completed its review and has no further questions regarding your submittal. Documentation of the NRC staff review is enclosed. If you have comments or questions regarding our review, please contact me at (301) 415-6606.

Sincerely,

A handwritten signature in black ink that reads "Joel S. Wiebe".

Joel S. Wiebe, Senior Project Manager
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. STN 50-456 and STN 50-457

Enclosure:
Review of Pressure and Temperature
Limits Report

cc w/encl: Distribution via Listserv



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REVIEW OF PRESSURE AND TEMPERATURE LIMITS REPORT

BRAIDWOOD STATION, UNITS 1 AND 2

DOCKET NOS. 50-456 AND 50-457

1.0 INTRODUCTION

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated February 28, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14059A124), Exelon Generation Company, LLC (the licensee) submitted the revised pressure and temperature limits report (PTLR) for the Braidwood Station, Units 1 and 2, as required by technical specification (TS) 5.6.6. The PTLR was revised to reflect changes resulting from the measurement uncertainty recapture (MUR) power uprate. By letter dated February 27, 2015 (ADAMS Accession No. ML15058A773), the licensee supplemented the submittal in response to the NRC staff's request for additional information (RAI) by e-mail dated January 29, 2015 (ADAMS Accession No. ML15030A007).

By application dated June 23, 2011 (ADAMS Accession No. ML111790030), the licensee submitted a license amendment request (LAR) to revise the Operating License and TSs to increase the licensed core power level by approximately 1.63 percent to 3645 megawatts thermal (MWt). The NRC staff reviewed the proposed request in accordance with Regulatory Information Summary (RIS) 2002-03, "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Applications," with respect to the integrity of the reactor vessel (RV) internal and core support structures. The licensee provided additional information in its letter dated November 1, 2011 (ADAMS Accession No. ML113050427). By letter dated February 7, 2014 (ADAMS Accession No. ML13281A000), the license amendment for the MUR power uprate was issued along with the staff's safety evaluation (SE).

2.0 REACTOR PRESSURE VESSEL INTEGRITY

The NRC staff's review in the area of RV integrity focuses on the impact of the proposed MUR power uprate RV pressure-temperature (P-T) limits and the RV surveillance capsule withdrawal schedules. Review of the MUR power uprate was conducted consistent with the guidance contained in RIS 2002-03. The staff reviewed the February 13, 2014, submittal to confirm that changes made to the PTLR accurately reflect the results of licensee analyses related the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendices G and H, for the implementation of the MUR power uprate as approved in the SE dated February 7, 2014.

Enclosure

2.2 P-T LIMITS

2.2.1 Regulatory Evaluation

Appendix G of 10 CFR Part 50 provides fracture toughness requirements for ferritic (low alloy steel or carbon steel) materials in the reactor coolant pressure boundary (RCPB) for assessing the safety margins of the RV materials against ductile tearing and for calculating P-T limits for the plant. These P-T limits are established to ensure the structural integrity of the ferritic components of the RCPB during any condition of normal operation, including anticipated operational occurrences and hydrostatic tests. The NRC staff's review covered the methodology and calculations for the number of effective full power years (EFPYs) specified for the P-T limits, considering neutron embrittlement effects on the RV beltline materials at MUR power uprate.

2.2.2 Technical Evaluation

As described in the staff's February 7, 2014, SE, the P-T limits in the Braidwood, Unit 1, PTLR, Revision 4, and the Braidwood, Unit 2, PTLR, Revision 4, are approved through 32 EFPY. In the June 23, 2011, submittal, the licensee stated that the current P-T limits in the Braidwood, Unit 1, PTLR, Revision 4, and Braidwood, Unit 2, PTLR, Revision 4, are approved through 32 EFPY. It further stated that, "[t]he limiting adjusted reference temperature (ART) values used in the development of the current P-T limit curves at 32 EFPY bound the MUR power uprate limiting ART values (at 32 EFPY) for both units. Therefore, the current heatup and cooldown curves are valid through end-of-licensed [EOL] plant life (32 EFPY) with the MUR power uprate and do not require update." In the SE dated February 7, 2014, the NRC staff accepted this conclusion because the maximum neutron fluence value on record (i.e., the Braidwood, Unit 1, PTLR, Revision 4, and the Braidwood, Unit 2, PTLR, Revision 4), bounded the MUR power uprate maximum reported values. Therefore, the limiting ART remains unchanged considering MUR power uprate. The staff determined that the current Braidwood, Units 1 and 2, P-T limits and low-temperature overpressure protection setpoints based on the same limiting ARTs remain valid through 32 EFPY.

The NRC staff determined that the February 28, 2014, submittal, accurately reflect the ART values of the MUR power uprate and the P-T limit curves in PTLR Figures 2.1 (Reactor Coolant System Heatup Limitations Applicable for 32 EFPY) and Figures 2.2 (Reactor Coolant System Cooldown Limitations for 32 EFPY) for Braidwood, Units 1 and 2.

2.3 RV MATERIAL SURVEILLANCE PROGRAM

2.3.1 Regulatory Evaluation

The RV material surveillance program provides a means for determining and monitoring the fracture toughness of the RV beltline materials to support analyses for ensuring the structural integrity of the ferritic components of the RV. Appendix H of 10 CFR Part 50 provides the requirements for the design and implementation of the RV material surveillance program.

2.3.2 Technical Evaluation

The surveillance program requirements in Appendix H of 10 CFR Part 50 were established to monitor the radiation-induced changes in the mechanical and impact properties of the RV materials. Appendix H of 10 CFR Part 50 requires licensees to monitor changes in the fracture toughness properties of ferritic materials in the RV beltline region of light-water nuclear power reactors. Appendix H of 10 CFR Part 50 states that the design of the surveillance program and the withdrawal schedule must meet the requirements of the edition of American Standard Testing of Materials (ASTM) E 185, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," that is current on the issue date of the American Society of Mechanical Engineers Boiler & Pressure Vessel Code, to which the RV was purchased. Later editions of ASTM E 185 may be used including those editions through 1982 (i.e., ASTM E 185-82). Since the license renewal application for Braidwood, Units 1 and 2, is currently under review, this evaluation is limited to the current 40-year period of operation for these units.

In the June 23, 2011, LAR, the licensee stated that the NRC-approved RV surveillance capsule withdrawal schedules for Braidwood, Units 1 and 2, are contained in the PTLR for each unit. It further stated that the current capsule withdrawal schedule in the PTLRs will be updated to reflect the latest capsule neutron fluence, lead factor, and withdrawal EFPY associated with each capsule. References for the latest capsule neutron fluence, lead factor, and withdrawal EFPY associated with each capsule were not given. Therefore, the NRC staff issued an RAI. In the November 1, 2011, response to this RAI, the licensee stated that the vessel and surveillance capsule neutron fluence values contained in the submittal were calculated as part of the MUR power uprate project and are not contained in any prior surveillance capsule reports. Since the revised neutron fluence calculations were based on the methodologies in WCAP-14040-A, Revision 4, "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves," and WCAP-16083-NP-A, Revision 0, "Benchmark Testing of the FERRET Code for Least Squares Evaluation of Light Water Reactor Dosimetry," which meet the requirements of Regulatory Guide 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," NRC staff concluded that the revised capsule neutron fluence, lead factor, and withdrawal EFPY associated with each capsule and the RV neutron fluence values were acceptable and the RAI was resolved. This information was reviewed and changes are accurately reflected in the February 28, 2014, submittal.

In the June 23, 2011, submittal, the licensee indicated that the surveillance capsule withdrawal schedules are consistent with ASTM E 185-82. Table 1 of ASTM E 185-82 requires that either a minimum of three, four, or five surveillance capsules be removed from each of the vessels, as based on the projected nil-ductility reference temperature shift ($\Delta RTNDT$) of the limiting material at the clad-vessel interface location of the RV at the EOL. Since Braidwood, Units 1 and 2, PTLRs indicated that the EOL $\Delta RTNDT$ values of each unit's limiting materials are less than 100 °F, the NRC staff determined that each Braidwood unit requires three surveillance capsules to meet the ASTM E 185-82 requirement for the current operating period. The RV materials surveillance program for each Braidwood unit contains six capsules, three are designated as required and three are standby. The three required capsules for each unit were withdrawn and tested to support current license operation. All standby capsules have also been withdrawn to

avoid excessive irradiation and for future use, but have not been tested. The NRC staff determined that the surveillance capsule withdrawal schedules for the current operating period accurately reflect the content and changes contained in the SE dated February 7, 2014.

3.0 CONCLUSION

The NRC staff concludes that the revisions to the licensee's PTLRs addressing P-T limits and surveillance capsule withdrawal schedules for Braidwood, Units 1 and 2, resulting from the MUR power uprate LAR dated June 23, 2011, are acceptable and consistent with the SE dated February 7, 2014.

Primary Reviewer: C. Fairbanks

Date of issuance: October 15, 2015

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Mr. Mark Kanavos
Site Vice President
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/RA/

Joel S. Wiebe, Senior Project Manager
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ADAMS Accession No.: ML15237A382

*via memo

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