



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

October 15, 2015

Mr. Faber A. Kearney  
Site Vice President  
Exelon Generation Company, LLC  
Byron Station  
4450 North German Church Road  
Byron, IL 61010-97945

SUBJECT: BYRON STATION, UNIT NOS. 1 AND 2 – PRESSURE AND TEMPERATURE  
LIMITS REPORT FOR MEASUREMENT UNCERTAINTY RECAPTURE  
POWER UPRATE (TAC NOS. MF3510 AND MF3511)

Dear Mr. Kearney:

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated February 13, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14044A019), Exelon Generation Company, LLC (Exelon) submitted the pressure and temperature limits report for measurement uncertainty recapture power uprate for Byron Station, Unit Nos. 1 and 2, as required by technical specification 5.6.6. By letter dated February 27, 2015 (ADAMS Accession No. ML15058A068), Exelon supplemented the submittal in response to the NRC staff's request for additional information by e-mail dated January 29, 2015 (ADAMS Accession No. ML15030A005).

The NRC staff has completed its review and has no further questions regarding your submittal. Documentation of the 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 50-454 and STN 50-455

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 Title 10 of the *Code of Federal Regulations* (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 the 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 the MUR power uprate.

### 2.2.2 Technical Evaluation

As described in the staff's February 7, 2014, SE, the P-T limits and low temperature overpressurization protection system setpoints in the 2006 Byron, Unit No. 1, PTLR are based on one quarter or three quarters of the RV wall thickness ( $\frac{1}{4}T$  or  $\frac{3}{4}T$ ) adjusted reference temperature (ART) values of 106 °F and 97 °F for the limiting material – the intermediate shell forging. Byron, Unit No. 2, has two limiting materials: the  $\frac{1}{4}T$  and  $\frac{3}{4}T$  ART values for the circumferential weld are 107 °F and 89 °F; the corresponding values for the nozzle shell forging are 52 °F and 37 °F. These values are contained in revised Figure 2.1 ("Byron Unit 1 Reactor Coolant System Heatup Limitations Applicable for 32 EFPY"), Figure 2.2 ("Byron Unit 1 Reactor Coolant System Cooldown Limitations Applicable for 32 EFPY"), Figure 2.1 ("Byron Unit 2 Reactor Coolant System Heatup Limitations Applicable for 30.5 EFPY"), and Figure 2.2 ("Byron Unit 2 Reactor Coolant System Cooldown Limitations Applicable for 30.5 EFPY").

In the MUR power uprate application, the licensee stated that, "For Unit 1, the limiting ART values used in the development of the current P-T limit curves at 32 EFPY bound the MUR power uprate limit ART values (at 32 EFPY)." The NRC staff accepted this conclusion because the maximum neutron fluence value on record (i.e., the 2006 Byron, Unit No. 1, PTLR) bounds the MUR maximum value reported in Table IV.1.C.ii-1 of Attachment 5. For Byron, Unit No. 2, the licensee stated in the application, "For Unit 2, the limiting ART values used in the development of the current P-T limit curves at 32 EFPY are slightly lower than the MUR power uprate limiting ART values (at 32 EFPY)." The staff could not verify this statement because the maximum neutron fluence value on record (i.e., the 2006 Byron, Unit No. 2, PTLR) also bounds the MUR maximum value reported in Table IV.1.C.ii-1 of the MUR power uprate application. Therefore, the staff requested additional information (RAI). The November 1, 2011, response to this RAI stated that the MUR power uprate neutron fluence value calculated specifically for the Byron, Unit No. 2, nozzle shell forging at 32 EFPY is greater than the neutron fluence value used in the development of the P-T limit curves in the 2006 Byron, Unit No. 2, PTLR for the nozzle shell forging at 32 EFPY. This neutron fluence increase for the Byron, Unit No. 2, nozzle shell forging material resulted in higher ART values at 32 EFPY for the MUR power uprate as compared to those used in the development of the 2006 P-T limit curves. The response further stated that the PTLR will be updated to reflect the MUR power uprate ART values and the 30.5 EFPY specified for the Byron, Unit No. 2, P-T limit curves. The NRC staff verified that the February 13, 2014, submittal contained the ART values reflecting the MUR power uprate and

the P-T limit curves in PTLR Figures 2.1 and 2.1 were revised to 30.5 EFPY for the Byron, Unit No. 2, P-T limit curves. The NRC staff determined that this is consistent with the resolution of the November 1, 2011, response to RAI-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). The license renewal application for Byron, Unit Nos. 1 and 2, is currently under review; however, 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 Byron, Unit Nos. 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 (RG) 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," 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. The staff determined that the changes are accurately reflected in the February 13, 2014, submittal.

### 3.0 CONCLUSION

The NRC staff concludes that the revisions to the licensee's PTLR addressing P-T limits and surveillance capsule withdrawal schedules for Byron, Unit Nos. 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. Faber A. Kearney  
Site Vice President  
Exelon Generation Company, LLC  
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*/RA/*

Joel S. Wiebe, Senior Project Manager  
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\*via memo

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