



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

October 28, 2015

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, AND BYRON STATION, UNIT NOS. 1 AND 2 - ISSUANCE OF AMENDMENTS TO UTILIZE WCAP-16143-P, REVISION 1 "REACTOR VESSEL CLOSURE HEAD/VESSEL FLANGE REQUIREMENTS EVALUATION FOR BYRON/BRAIDWOOD UNITS 1 AND 2," DATED OCTOBER 16, 2014 (CAC NOS. MF5033, MF5034, MF5035 AND MF5036)

Dear Mr. Hanson:

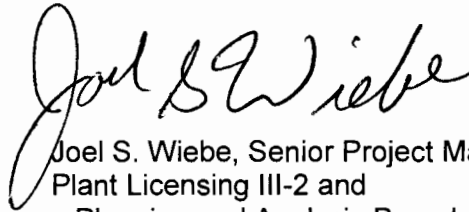
The U.S. Nuclear Regulatory Commission (NRC) has issued the enclosed Amendment No. 186 to Facility Operating License No. NPF-72 and Amendment No. 186 to Facility Operating License No. NPF-77 for the, Braidwood Station, Units 1 and 2, respectively, and Amendment No. 192 to Facility Operating License No. NPF-37 and Amendment No. 192 to Facility Operating License No. NPF-66 for the Byron Station, Unit Nos. 1 and 2, respectively. The amendments are in response to your application dated October 16, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14289A580), as supplemented by letter dated May 27, 2015 (ADAMS Accession No. ML15161A390)

B. Hanson

- 2 -

A copy of the Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

A handwritten signature in black ink, reading "Joel S. Wiebe". The signature is written in a cursive style with a large, prominent "J" and "W".

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 Nos. STN 50-456, STN 50-457,
STN 50-454 and STN 50-455

Enclosures:

1. Amendment No. 186 to NPF-72
2. Amendment No. 186 to NPF-77
3. Amendment No. 192 to NPF-37
4. Amendment No. 192 to NPF-66
5. Safety Evaluation

cc w/encls: Distribution via Listserv



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

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-456

BRAIDWOOD STATION, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 186
License No. NPF-72

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated October 16, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML14289A580), as supplemented by letter dated May 27, 2015 (ADAMS Accession Number ML15161A390), complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public, and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C. (2) of Facility Operating License No. NPF-72 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 186 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 60 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Travis L. Tate, Branch Chief
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Facility Operating License

Date of Issuance: October 28, 2015



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

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-457

BRAIDWOOD STATION, UNIT 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 186
License No. NPF-77

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated October 16, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML14289A580), as supplemented by letter dated May 27, 2015 (ADAMS Accession Number ML15161A390), complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C. (2) of Facility Operating License No. NPF-77 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 186 and the Environmental Protection Plan contained in Appendix B, both of which were attached to License No. NPF-72, dated July 2, 1987, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 60 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Travis L. Tate, Branch Chief
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Facility Operating License

Date of Issuance: October 28, 2015

ATTACHMENT TO LICENSE AMENDMENT NOS. 186 AND 186

FACILITY OPERATING LICENSE NOS. NPF-72 AND NPF-77

DOCKET NOS. STN 50-456 AND STN 50-457

Replace the following pages of the Facility Operating Licenses and Appendix "A" Technical Specifications with the attached pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove

License NPF-72
Page 3

License NPF-77
Page 3

TSs
1.1-9

Insert

License NPF-72
Page 3

License NPF-77
Page 3

TSs
1.1-9

- (3) Exelon Generation Company, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;
 - (4) Exelon Generation Company, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
 - (5) Exelon Generation Company, pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.
- C. The license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:
- (1) Maximum Power Level

The licensee is authorized to operate the facility at reactor core power levels is not in excess of 3645 megawatts thermal (100 percent rated power) in accordance with the conditions specified herein and other items identified in Attachment 1 to this license. The items identified in Attachment 1 to this license shall be completed as specified. Attachment 1 is hereby incorporated into this license.
 - (2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 186 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into the license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.
 - (3) Emergency Planning

In the event that the NRC finds that the lack of progress in completion of the procedures in the Federal Emergency Management Agency's final rule, 44 CFR Part 350, is an indication that a major substantive problem exists in achieving or maintaining an adequate state of emergency preparedness, the provision of 10 CFR Section 50.54(s)(2) will apply.

material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required.

- (4) Exelon Generation Company, LLC pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts are required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
- (5) Exelon Generation Company, LLC pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

C. The license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at reactor core power levels is not in excess of 3465 megawatts thermal (100 percent rated power) in accordance with the conditions specified herein and other items identified in Attachment 1 to this license. The items identified in Attachment 1 to this license shall be completed as specified. Attachment 1 is hereby incorporated into this license.

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 186 and the Environmental Protection Plan contained in Appendix B, are of which are attached to License No. NPF-72, dated July 2, 1987, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Emergency Planning

In the event that the NRC finds that the lack of progress in completion of the procedures in the Federal Emergency Management Agency's final rule, 44 CFR Part 350, is an indication that a major substantive problem exists in achieving or maintaining an adequate state of emergency preparedness, the provision of 10 CFR Section 50.54(s)(2) will apply.

Table 1.1-1 (page 1 of 1)
MODES

MODE	TITLE	REACTIVITY CONDITION (k_{eff})	% RATED THERMAL POWER ^(a)	AVERAGE REACTOR COOLANT TEMPERATURE (°F)
1	Power Operation	≥ 0.99	> 5	NA
2	Startup	≥ 0.99	≤ 5	NA
3	Hot Standby	< 0.99	NA	≥ 350
4	Hot Shutdown ^(b)	< 0.99	NA	$350 > T_{ava} > 200$
5	Cold Shutdown ^(b)	< 0.99	NA	≤ 200
6	Refueling ^(c)	NA	NA	NA

(a) Excluding decay heat.

(b) All required reactor vessel head closure bolts fully tensioned. |

(c) One or more required reactor vessel head closure bolts less than fully tensioned. |



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

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-454

BYRON STATION, UNIT NO. 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 192
License No. NPF-37

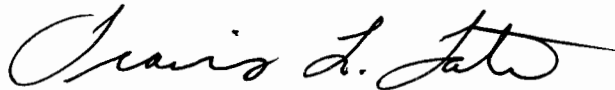
1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated October 16, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML14289A580), as supplemented by letter dated May 27, 2015 (ADAMS Accession Number ML15161A390), complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-37 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 192 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 60 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION



Travis L. Tate, Branch Chief
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Facility Operating License

Date of Issuance: October 28, 2015



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

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-455

BYRON STATION, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 192
License No. NPF-66

1. The Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated October 16, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML14289A580), as supplemented by letter dated May 27, 2015 (ADAMS Accession Number ML15161A390), complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;
 - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
 - C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
 - D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and
 - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.
2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C. (2) of Facility Operating License No. NPF-66 is hereby amended to read as follows:

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A (NUREG-1113), as revised through Amendment No. 192 and the Environmental Protection Plan contained in Appendix B, both of which were attached to License No. NPF-37, dated February 14, 1985, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance and shall be implemented within 60 days of the date of issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

A handwritten signature in black ink, appearing to read "Travis L. Tate". The signature is fluid and cursive, with the first name being the most prominent.

Travis L. Tate, Branch Chief
Plant Licensing III-2 and
Planning and Analysis Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Facility Operating License

Date of Issuance: October 28, 2015

ATTACHMENT TO LICENSE AMENDMENT NOS. 192 AND 192

FACILITY OPERATING LICENSE NOS. NPF-37 AND NPF-66

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

Replace the following pages of the Facility Operating License and Appendix AA@ Technical Specifications with the attached pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove

Insert

License NPF-37
Page 3

License NPF-37
Page 3

License NPF-66
Page 3

License NPF-66
Page 3

TSs
Page 1.1-9

TS
Page 1.1-9

- (4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source and special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
 - (5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.
- C. The license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:
- (1) Maximum Power Level
The licensee is authorized to operate the facility at reactor core power levels not in excess of 3645 megawatts thermal (100 percent power) in accordance with the conditions specified herein.
 - (2) Technical Specifications
The Technical Specifications contained in Appendix A as revised through Amendment No. 192 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.
 - (3) Deleted.
 - (4) Deleted.
 - (5) Deleted.
 - (6) The license shall implement and maintain in effect all provisions of the approved fire protection program as described in the licensee's Fire Protection Report, and as approved in the SER dated February 1987 through Supplement No. 8, subject to the following provision:

The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

- (3) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use at any time any byproduct, source and special nuclear material as sealed neutron sources for reactor startup, sealed sources for reactor instrumentation and radiation monitoring equipment calibration, and as fission detectors in amounts as required;
- (4) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to receive, possess, and use in amounts as required any byproduct, source or special nuclear material without restriction to chemical or physical form, for sample analysis or instrument calibration or associated with radioactive apparatus or components; and
- (5) Pursuant to the Act and 10 CFR Parts 30, 40 and 70, to possess, but not separate, such byproduct and special nuclear materials as may be produced by the operation of the facility.

B. The license shall be deemed to contain and is subject to the conditions specified in the Commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations and orders of the Commission now or hereafter in effect; and is subject to the additional conditions specified or incorporated below:

(1) Maximum Power Level

The licensee is authorized to operate the facility at reactor core power levels not in excess of 3645 megawatts thermal (100 percent rated power) in accordance with the conditions specified herein.

(2) Technical Specifications

The Technical Specifications contained in Appendix A (NUREG-1113), as revised through Amendment No. 192 and the Environmental Protection Plan contained in Appendix B, both of which were attached to License No. NPF-66, dated February 14, 1985, are hereby incorporated into this license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Deleted.

(4) Deleted.

(5) Deleted.

Table 1.1-1 (page 1 of 1)
MODES

MODE	TITLE	REACTIVITY CONDITION (k_{eff})	% RATED THERMAL POWER ^(a)	AVERAGE REACTOR COOLANT TEMPERATURE (°F)
1	Power Operation	≥ 0.99	> 5	NA
2	Startup	≥ 0.99	≤ 5	NA
3	Hot Standby	< 0.99	NA	≥ 350
4	Hot Shutdown ^(b)	< 0.99	NA	$350 > T_{avg} > 200$
5	Cold Shutdown ^(b)	< 0.99	NA	≤ 200
6	Refueling ^(c)	NA	NA	NA

(a) Excluding decay heat.

(b) All required reactor vessel head closure bolts fully tensioned. |

(c) One or more required reactor vessel head closure bolts less than fully tensioned. |



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 186 TO FACILITY OPERATING LICENSE NO. NPF-72,
AMENDMENT NO. 186 TO FACILITY OPERATING LICENSE NO. NPF-77,
AMENDMENT NO. 192 TO FACILITY OPERATING LICENSE NO. NPF-37,
AND AMENDMENT NO. 192 TO FACILITY OPERATING LICENSE NO. NPF-66

EXELON GENERATION COMPANY, LLC

BRAIDWOOD STATION, UNITS 1 AND 2

BYRON STATION, UNIT NOS. 1 AND 2

DOCKET NOS. STN 50-456, STN 50-457,

STN 50-454, AND STN 50-455.

1.0 INTRODUCTION

By application to the U.S. Nuclear Regulatory Commission (NRC or Commission) dated October 16, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14289A580), as supplemented by letter dated May 27, 2015 (ADAMS Accession No. ML15161A390), Exelon Generation Company, LLC (the licensee) requested changes to the technical specifications (TSs) and facility operating licenses for the Braidwood Station (Braidwood), Units 1 and 2, and Byron Station (Byron), Unit Nos. 1 and 2. The proposed changes would permit utilization of WCAP-16143-P, Revision 1, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation for Byron/Braidwood Units 1 and 2," dated October 2014, as an analytical method to determine the reactor coolant system pressure and temperature (P/T) limits.

The May 27, 2015, supplement, contained clarifying information and did not change the scope of the proposed action or affect the NRC staff's initial proposed finding of no significant hazards consideration, as published in the *Federal Register* (80 FR 11494; dated March 3, 2015).

The reactor pressure vessel (RPV) is closed with a bolt arrangement, with each bolt consisting of a stud (the threaded portion) and a nut that threads onto the stud to hold the RPV head in place during operation. To prepare for refueling, the nuts are unthreaded first, then the RPV head is removed, and finally, the studs are removed to avoid interference with refueling operations. In the discussion, below, the term bolt is used to refer to nut and stud functioning as

a unit. The term stud is used when referring to just the threaded portion of the bolt. In the supporting technical documents, the terms bolt and stud are sometimes used interchangeably.

2.0 REGULATORY EVALUATION

The applicable regulatory requirements on which the staff based its acceptance are identified in Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.60, "Acceptance criteria for fracture prevention measures for light water nuclear power reactors for normal operation." Paragraph (a) of 10 CFR 50.60 states that the reactor coolant system pressure boundary must meet the fracture toughness requirements of 10 CFR, Part 50, Appendix G, "Fracture Toughness Requirements." Paragraph (b) of 10 CFR 50.60 allows alternatives to the Appendix G requirements when an exemption is granted under 10 CFR 50.12, "Specific exemptions."

By letter dated November 22, 2006 (ADAMS Accession No. ML061890003), the NRC forwarded an Exemption granted (and later published at 71 FR 69598; dated December 1, 2006) in response to the licensee's Request for Exemption. By letter dated November 27, 2006 (ADAMS Accession No. ML062610513), NRC issued amendments to allow use of the methodology in WCAP-16143-P for developing the pressure and temperature limits report (PTLR). However, the technical basis for the Exemption and the amendments was Revision 0 of WCAP-16143-P which provided an analysis for a RPV closure head with the full-bolt configuration of 54. The proposed amendment request includes Revision 1 of WCAP-16143-P, which provides a stress and fracture mechanics analysis of the RPV closure head with one missing bolt, and compares it to the case with no missing bolt, as a technical basis to justify the continuation of the exemption from 10 CFR, Part 50, Appendix G.

Section 5.6.6, "Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR)," Item (b) of the TS for Braidwood and Byron requires that the analytical methods used to determine the RCS P/T limits shall be those previously reviewed and approved by the NRC, and provides a specific list of references. This TS requires, the PTLR to be updated to reflect the latest WCAP revision number and report date.

3.0 TECHNICAL EVALUATION

The NRC staff has reviewed the licensee's regulatory and technical analyses in support of its proposed license amendment which are described in Sections 3.0 and 4.0 of the licensee's submittal.

The NRC staff compared the contents of Revision 1 of WCAP-16143-P with those of Revision 0 of WCAP-16143-P and has identified the following differences:

- Addition of descriptions of Revision 1 changes on pages 1-1, 5-2, and 5-3
- Addition of Reference 13, "Design Information Transmittal DIT-BRW-2014-0059/BYR14051, Revision 0, Braidwood, Unit 2, and Byron Unit 2, dated September 2014," on page 7-1
- References to Appendix F in Appendix C, page C-1 (not visible in public version, because the context is withheld as proprietary)

- Addition of Appendix E, "Reevaluation of Byron and Braidwood Reactor Vessel Closure Head/Vessel Flange Requirements to Account for a Missing Closure Stud"
- Addition of Appendix F, "Stress Distributions in the Closure Head Region for Plant Specific Three-Dimensional Finite Element Models"

The first three items listed above generally describe the scope and the nature of the differences from Revision 0, and reference the additional appendices that support the changes. These revisions are administrative in nature, and, therefore, no further evaluation is needed.

3.1 Addition of Appendix E

In Appendix E of Revision 1 of WCAP-16143-P, the licensee presented the evaluation of the Braidwood and Byron RPV closure head flange requirements with one missing bolt and a comparison with the case of no missing bolt. The evaluation and comparison consist of two basic steps: a thermal and stress analysis followed by a fracture mechanics analysis.

3.1.1 Thermal and Stress Analysis

The licensee created two three-dimensional (3D) finite element analyses (FEA) models: one FEA model is with one missing bolt and one FEA model is with all bolts intact (no missing bolt). Each 3D FEA model is a sector symmetry model that includes the RPV closure head, the RPV flange, a portion of the RPV upper shell course, and the closure head bolts. The location of the missing bolt is in the center planar locations (planar cuts) of the sector. The licensee used these two 3D FEA models to simulate a heatup-cooldown transient. The initial condition is the boltup condition.

The licensee applied thermal and mechanical boundary conditions that are consistent with standard practice for FEA. The licensee then performed stress analyses that combine time-varying temperature and internal pressure loads from the heatup-cooldown transient. The initial condition is the boltup condition, which is simulated by applying tensile loading to the bolts that are included in the FEA models.

The licensee's analysis indicated that the governing location is in the closure head just above the flange. This conclusion is based on through-wall stresses at several vertical locations at several azimuthal planar cuts. The licensee presented the stress distributions at the governing location in Appendix F. These stress distributions are further evaluated in Section 3.2 of this safety evaluation (SE). In addition, the reported magnitude of the stress at the outer surface for the boltup condition at the limiting flange location is comparable to the stresses for the boltup condition for similar closure heads at the same flange location, as documented in a review of bending stresses in the flange region after the RPV closure head bolts are tensioned (Electric Power Research Institute, Materials Reliability Program (MRP) Letter, MRP 2012-001 from Tim Wells (Southern Company) to Dr. A Csontos (NRC), "Validation of Reactor Pressure Vessel Flange Stresses in Support of Revising 10 CFR 50, Appendix G," dated January 5, 2012 (ADAMS Accession No. ML12030A039)). This comparison gives the NRC staff additional confidence that the stresses determined from the FEA are reasonable.

Since the licensee has used standard FEA modeling techniques, properly considered stresses at several locations to determine the governing location at the closure head and vessel flange

region, and the resulting stress distribution patterns do not indicate modelling errors, the NRC staff determined that the licensee's calculated stresses are credible and can be used in Section E.3 "Fracture Mechanics Analysis" of Revision 1 of WCAP-16143-P.

3.1.2 Fracture Mechanics Analysis

In the fracture mechanics analysis, the licensee took the stress distributions from Appendix F and calculated applied stress intensity factors (K) from published K solution equations in the American Society of Mechanical Engineers and American Petroleum Institute's fitness-for-service standard 579. The licensee used the K solution equation for a surface flaw on the outside surface of a cylindrical body, which reasonably approximates a surface flaw in the closure head just above the flange. The applied K is calculated at the maximum depth of the postulated flaw and is for a length-to-depth ratio of 6. The applied K distributions are multiplied by 2 as required by Appendix G of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code.

For the boltup condition, the licensee used a material fracture toughness (K_{IC}) value calculated from Appendix G of Section XI of the ASME B&PV Code at the nil ductility transition reference temperature (RT_{NDT}) that is limiting for Braidwood and Byron, Units 1 and 2. This limiting RT_{NDT} is expected to be lower than the ambient temperature (containment temperature) of the RPV at the start of a heatup transient. The ambient temperature is the expected temperature at the start of a heatup transient, which should be the same temperature used in the FEA discussed in Section 3.1.1 of this SE. The NRC staff was concerned that between the boltup temperature and the temperature at the start of heatup, there could be a limiting condition at some time immediately after boltup, when the temperature is still low and the value of K_{IC} is only slightly higher than the K_{IC} at the boltup temperature. Therefore, on April 6, 2015, the NRC staff issued a request for additional information (RAI) (ADAMS Accession No. ML15112A141), and requested in RAI 1 that the licensee confirm the expected ambient temperature around the RPV at the start of the heatup transient. In a letter dated May 27, 2015 (ADAMS Accession No. ML15161A390), the licensee clarified that the temperature indicated in Table F-1, "Stress for Upper Head to Flange Transition Region from Three-Dimensional Finite Element Model" of WCAP-16143-P, Revision 1 for "time = 1 second" does apply to 1 second into the heatup transient. Additionally, the licensee stated that between boltup and start of heatup there are no significant thermal and pressure transients. The NRC staff accepts these responses and hence, considers RAI 1 resolved.

The licensee computed the limiting flaw depth for the case with one missing bolt and for the case with all bolts intact by determining the point in the K versus flaw depth plot where the applied K, multiplied by 2, intersects the K_{IC} line. The licensee then assessed the probability of detection (POD) of the limiting flaw depths that were based on the performance demonstration requirements of ultrasonic testing (UT) systems of Appendix VIII of Section XI of the ASME B&PV Code. The licensee considered POD values from UT examiners that passed the performance demonstration and UT examiners that failed the performance demonstration and reported POD values from the limiting POD distribution. The NRC staff was concerned about the POD values reported by the licensee because those values indicate the possibility that a flaw with the calculated limiting flaw depths may be missed by the inspection techniques used. Therefore, the NRC staff asked in RAI 3 which POD distribution best represents the examiners that perform the UT examinations at Braidwood and Byron, Units 1 and 2, RPV flanges. In its

response by letter dated May 27, 2015, the licensee stated that only examiners that passed the performance demonstration would actually perform the inspections in the field, in which case the actual POD values would be more accurately represented by the POD distribution in Figure 5-2 of Revision 1 of WCAP-16143-P. In addition, the licensee's response indicated that past inspections have included surface inspections in addition to volumetric inspections, and that the surface inspection technique used is reasonably expected to detect shallow, surface-breaking flaws. The licensee's responses provide reasonable assurance that the limiting flaw depths determined by the licensee in the fracture mechanics analysis are detectable. Hence, the NRC staff considers RAI 3 resolved and the fracture mechanics analysis results reasonable and acceptable.

3.2 Addition of Appendix F

In Appendix F of Revision 1 of WCAP-16143-P, the licensee provided through-wall stress distributions at the limiting location from the FEA in Appendix E for the case with all closure bolts intact and for the case with one missing bolt. These stress distributions are at the closure head-to-flange weld location and are for several time steps during a heatup-cooldown transient (internal pressure included). Boltup conditions are applied before the beginning of the transient. During the transient, the stresses due to internal pressure and thermal transient stresses are linearly superimposed on the boltup stresses. This linear superposition of loads is consistent with the loading application used for the analysis in Revision 0 of WCAP-16143-P. The stresses shown in Appendix F of Revision 1 of WCAP-16143-P were from the governing planar cut as described in Section E.2 "Technical Approach" of Revision 1 of WCAP-16143-P and are used as input in calculating applied K as described in Section E.3.1 "Stress Intensity Factor Calculation". The licensee included in Appendix F descriptions of the thermal and mechanical boundary conditions of the FEA, which are evaluated in Section 3.1.1 of this SE.

To verify fidelity of the FEA results, in RAI 2, the NRC staff requested the licensee to identify, for the one missing bolt case, the stresses in the flange in the center-of-bolt plane (6.66° cut plane) immediately adjacent to the missing bolt. The stresses provided in Appendix F of Revision 1 of WCAP-16143-P for the one missing bolt case are at the 13.33° cut plane, which is two bolts away from the missing bolt. The NRC staff's concern is that the stresses at 13.33° cut plane may not represent the maximum stresses for the one missing bolt case. In a letter dated May 27, 2015, the licensee responded to RAI 2 by providing stress contour plots of the all-bolt case and one missing bolt case and stating that a major contribution to the stresses in the surrounding material, which includes the stresses in the flange region, is the stresses due to boltup conditions. This means that for the one missing bolt case, the major contributor to stresses in the flange region at the 6.66° cut plane is from the bolt preload at the 6.66° cut plane. In the response to RAI 2, the licensee also stated that for the case with one missing bolt, this stress contribution due to preload is slightly higher than the stress contribution for the case with all bolts intact. The NRC staff accepts this explanation of the influence of the missing bolt on stress at the 6.66° cut plane. Additionally, the licensee explains that further away from the missing bolt, the effect of the missing bolt attenuates. This means that at the missing bolt location where the effect of the missing bolt is greatest, stresses in the flange are lowest. Then, stresses increase at the 6.66° cut plane, increase some more at the 13.33° cut plane, and approach the stress condition identical to the case with all bolts intact for all other flange locations. The NRC staff accepts this explanation of the attenuation effect of the missing bolt,

and, therefore, accepts that the stresses at the 13.33° cut plane for the missing bolt case represent the maximum stress. Thus, the NRC staff finds RAI 2 resolved. Therefore, the NRC staff determines that the stress distributions provided in Appendix F of Revision 1 of WCAP-16143-P are valid input into the fracture mechanics analysis of Appendix E of Revision 1 of WCAP-16143-P, which is evaluated in Section 3.1.2 of this SE.

3.3 Technical Specification (TS) Changes

Current TS Notes (b) and (c) to Table 1.1-1

- (b) All reactor vessel head closure bolts fully tensioned.
- (c) One or more reactor vessel head closure bolts less than fully tensioned.

Proposed TS Notes (b) and (c) to Table 1.1-1

- (b) All required reactor vessel head closure bolts fully tensioned.
- (c) One or more required reactor vessel head closure bolts less than fully tensioned.

Based on the above evaluation, the NRC staff finds that the flaw tolerance analyses the licensee has provided in Revision 1 of WCAP-16143-P demonstrated that the case with full-bolt configuration (54 closure head bolts in operation) bounds the case with one missing bolt (53 closure head bolts in operation). The licensee also demonstrated in Revision 1 of WCAP-16143-P, that the limiting flaw depths in the flaw tolerance analyses are detectable. For these reasons, the NRC staff determined that the licensee's analyses provide reasonable assurance of structural integrity of the flange region, and, therefore, the licensee meets 10 CFR 50.60, "Acceptance criteria for fracture prevention measures for light-water nuclear power reactors for normal operation." The NRC staff also determined that the special circumstance identified in the exemption granted from 10 CFR, Part 50, Appendix G, flange requirements conditions, continues to exist because the full-bolt configuration analysis, which provided the basis for the finding of special circumstance to grant the exemption, bounds the case with one missing bolt.

The proposed TS are acceptable because the change provides clarification that not all reactor vessel head closure bolts are required to be tensioned based on the NRC acceptance of Revision 1 of WCAP-16143.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State official was notified on August 11, 2015, of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change the requirements with respect to installation or use of a facility's components located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no

significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (80 FR 11494; March 3, 2015). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: D. Dijamco

Date of issuance: October 28, 2015

B. Hanson

- 2 -

A copy of the Safety Evaluation is also enclosed. The Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

Sincerely,

/RA/

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 Nos. STN 50-456, STN 50-457,
STN 50-454 and STN 50-455

Enclosures:

1. Amendment No. 186 to NPF-72
2. Amendment No. 186 to NPF-77
3. Amendment No. 192 to NPF-37
4. Amendment No. 192 to NPF-66
5. Safety Evaluation

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