



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

August 1, 2016

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 REGARDING USE OF OPTIMIZED ZIRLO™ AS FUEL CLADDING MATERIAL (CAC NOS. MF7403, MF7404, MF7405, AND MF7406)

Dear Mr. Hanson:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment No. 190 to Renewed Facility Operating License No. NPF-72 and Amendment No. 190 to Renewed Facility Operating License No. NPF-77 for the Braidwood Station, Units 1 and 2, respectively, and Amendment No. 196 to Renewed Facility Operating License No. NPF-37 and Amendment No. 196 to Renewed 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 February 23, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16055A149).

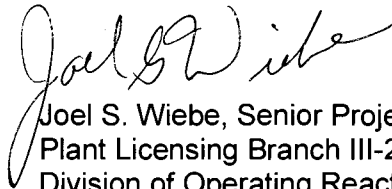
The amendments revise TS 4.2.1, "Fuel Assemblies," and TS 5.6.5, "Core Operating Limits Report (COLR)," to allow the use of Optimized ZIRLO™ fuel cladding material in both Braidwood Station, Units 1 and 2, and Byron Station, Unit Nos. 1 and 2 and to add associated methodologies for determining the limits in the COLR.

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,



Joel S. Wiebe, Senior Project Manager
Plant Licensing Branch III-2
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. 190 to NPF-72
2. Amendment No. 190 to NPF-77
3. Amendment No. 196 to NPF-37
4. Amendment No. 196 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 RENEWED FACILITY OPERATING LICENSE

Amendment No. 190
Renewed License No. NPF-72

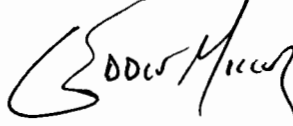
1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated February 23, 2016, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's 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 Renewed 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. 190 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into the renewed 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 "G. Edward Miller". The signature is stylized and cursive.

G. Edward Miller, Acting Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Renewed Facility Operating License

Date of Issuance: August 1, 2016



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 RENEWED FACILITY OPERATING LICENSE

Amendment No. 190
Renewed License No. NPF-77

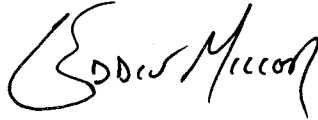
1. The U.S. Nuclear Regulatory Commission (the Commission) has found that:
 - A. The application for amendment by Exelon Generation Company, LLC (the licensee) dated February 23, 2016, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's 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 Renewed 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. 190 and the Environmental Protection Plan contained in Appendix B, both of which are attached to Renewed License No. NPF-72, dated January 27, 2016, are hereby incorporated into the renewed 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 "G. Edward Miller". The signature is fluid and cursive, written over a white background.

G. Edward Miller, Acting Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Renewed Facility Operating License

Date of Issuance: August 1, 2016

ATTACHMENT TO LICENSE AMENDMENT NOS. 190 AND 190

BRAIDWOOD STATION, UNITS 1 AND 2

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

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

Replace the following pages of the Renewed Facility Operating Licenses and Appendix A Technical Specifications with the attached revised 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
Page 4.0-1
Page 5.6-3
Page 5.6-4

Insert

License NPF-72
Page 3

License NPF-77
Page 3

TSs
Page 4.0-1
Page 5.6-3
page 5.6-4

- (2) Exelon Generation Company, pursuant to the Act and 10 CFR Part 70, to receive, possess and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended;
- (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. This renewed 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 as revised through Amendment No. 190 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into the renewed license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

- (2) Exelon Generation Company, LLC, pursuant to the Act and 10 CFR Part 70, to receive, possess and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Final Safety Analysis Report, as supplemented and amended;
- (3) Exelon Generation Company, LLC, 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, LLC, 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, 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. This renewed 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 as revised through Amendment No. 190 and the Environmental Protection Plan contained in Appendix B, both of which are attached to Renewed License No. NPF-72, dated January 27, 2016, are hereby incorporated into the renewed license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

4.0 DESIGN FEATURES

4.1 Site

4.1.1 Site Location

The site is located in Reed Township, approximately 20 mi (32 km) south-southwest of the city of Joliet in northern Illinois.

4.1.2 Exclusion Area Boundary (EAB)

The EAB shall not be less than 1591 ft (485 meters) from the outer containment wall.

4.1.3 Low Population Zone (LPZ)

The LPZ shall be a 1.125 mi (1811 meter) radius measured from the midpoint between the two reactors.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly, with exceptions as noted below, shall consist of a matrix of Zircaloy, ZIRLO®, or Optimized ZIRLO™ clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO₂) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods or vacancies for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

Up to 8 AREVA NP Advanced Mark-BW(A) fuel assemblies containing M5 alloy may be placed in nonlimiting Unit 1 core regions for evaluation during Cycles 15, 16, and 17.

4.2.2 Control Rod Assemblies

The reactor core shall contain 53 control rod assemblies. The control material shall be silver indium cadmium, hafnium, or a mixture of both types.

5.6 Reporting Requirements

5.6.5 CORE OPERATING LIMITS REPORT (COLR)

- a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:
- SL 2.1.1, "Reactor Core SLs";
 - LCO 3.1.1, "SHUTDOWN MARGIN (SDM)";
 - LCO 3.1.3, "Moderator Temperature Coefficient";
 - LCO 3.1.5, "Shutdown Bank Insertion Limits";
 - LCO 3.1.6, "Control Bank Insertion Limits";
 - LCO 3.1.8, "PHYSICS TESTS Exceptions - MODE 2";
 - LCO 3.2.1, "Heat Flux Hot Channel Factor ($F_0(Z)$)";
 - LCO 3.2.2, "Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^N$)";
 - LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)";
 - LCO 3.2.5, "Departure from Nucleate Boiling Ratio (DNBR)";
 - LCO 3.4.1, "RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits"; and
 - LCO 3.9.1, "Boron Concentration";
- b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:
1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluations Methodology," July 1985.
 2. WCAP-12472-P-A, "BEACON Core Monitoring and Operations Support System," August 1994.
 3. NFSR-0016, "Commonwealth Edison Company Topical Report on Benchmark of PWR Nuclear Design Methods," July 1983.
 4. NFSR-0081, "Commonwealth Edison Company Topical Report on Benchmark of PWR Nuclear Design Methods Using the Phoenix-P and ANC Computer Codes," July 1990.
 5. ComEd letter from D. Saccomando to the Office of Nuclear Reactor Regulation dated December 21, 1994, transmitting an attachment that documents applicable sections of WCAP-11992/11993 and ComEd application of the UET methodology addressed in "Additional Information Regarding Application for Amendment to Facility Operating Licenses-Reactivity Control Systems."

5.6 Reporting Requirements

5.6.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

6. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005.
 7. WCAP-10079-P-A, "NOTRUMP, A Nodal Transient Small Break and General Network Code," August 1985.
 8. WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using NOTRUMP Code," August 1985.
 9. WCAP-10216-P-A, Revision 1, "Relaxation of Constant Axial Offset Control - F₀ Surveillance Technical Specification," February 1994.
 10. WCAP-8745-P-A, "Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.
 11. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999.
 12. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995, (Westinghouse Proprietary).
 13. WCAP-12610-P-A & CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," July 2006, (Westinghouse Proprietary).
- c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems (ECCS) limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met; and
- d. The COLR, including any midcycle revisions or supplements, shall be provided upon issuance for each reload cycle to the NRC.



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 RENEWED FACILITY OPERATING LICENSE

Amendment No. 196
Renewed License No. NPF-37

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 February 23, 2016, 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 Renewed Facility Operating License No. NPF-37 is hereby amended to read as follows:

Enclosure 3

(2) Technical Specifications

The Technical Specifications contained in Appendix A as revised through Amendment No. 196 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this renewed 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



G. Edward Miller, Acting Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Renewed Facility Operating License

Date of Issuance: August 1, 2016



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 RENEWED FACILITY OPERATING LICENSE

Amendment No. 196
Renewed License No. NPF-66

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 February 23, 2016, 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 Renewed Facility Operating License No. NPF-66 is hereby amended to read as follows:

Enclosure 4

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A (NUREG-1113), as revised through Amendment No. 196 and the Environmental Protection Plan contained in Appendix B, both of which were attached to Renewed License No. NPF-37, dated November 19, 2015, are hereby incorporated into this renewed 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



G. Edward Miller, Acting Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment: Changes to the Technical
Specifications and Renewed Facility Operating License

Date of Issuance: August 1, 2016

ATTACHMENT TO LICENSE AMENDMENT NOS. 196 AND 196

BRYON STATION, UNIT NOS. 1 AND 2

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

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

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

Remove

License NPF-37
Page 3

License NPF-66
Page 3

TSs

Page 4.0-1
Page 5.6-3
Page 5.6-4

Insert

License NPF-37
Page 3

License NPF-66
Page 3

TSs

Page 4.0-1
Page 5.6-3
page 5.6-4

- (2) Pursuant to the Act and 10 CFR Part 70, to receive, possess and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Updated Final Safety Analysis Report, as supplemented and amended;
- (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.

C. This renewed 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 as revised through Amendment No. 196 and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this renewed license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

(3) Deleted.

(4) Deleted.

- (2) Pursuant to the Act and 10 CFR Part 70, to receive, possess and use at any time special nuclear material as reactor fuel, in accordance with the limitations for storage and amounts required for reactor operation, as described in the Updated Final Safety Analysis Report, as supplemented and amended;
- (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.

C. The renewed 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. 196 and the Environmental Protection Plan contained in Appendix B, both of which were attached to Renewed License No. NPF-37, dated November 19, 2015, are hereby incorporated into this renewed license. The licensee shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

4.0 DESIGN FEATURES

4.1 Site

4.1.1 Site Location

The site is located in Rockvale Township, approximately 3.73 mi (6 km) south-southwest of the city of Byron in northern Illinois.

4.1.2 Exclusion Area Boundary (EAB)

The EAB shall not be less than 1460 ft (445 meters) from the outer containment wall.

4.1.3 Low Population Zone (LPZ)

The LPZ shall be a 3.0 mi (4828 meter) radius measured from the midpoint between the two reactors.

4.2 Reactor Core

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of Zircaloy, ZIRLO[®], or Optimized ZIRLO[™] clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO₂) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods or vacancies for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

4.2.2 Control Rod Assemblies

The reactor core shall contain 53 control rod assemblies. The control material shall be silver indium cadmium, hafnium, or a mixture of both types.

5.6 Reporting Requirements

5.6.5 CORE OPERATING LIMITS REPORT (COLR)

- a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

SL 2.1.1, "Reactor Core SLs";
LCO 3.1.1, "SHUTDOWN MARGIN (SDM)";
LCO 3.1.3, "Moderator Temperature Coefficient";
LCO 3.1.5, "Shutdown Bank Insertion Limits";
LCO 3.1.6, "Control Bank Insertion Limits";
LCO 3.1.8, "PHYSICS TESTS Exceptions - MODE 2";
LCO 3.2.1, "Heat Flux Hot Channel Factor ($F_0(Z)$)";
LCO 3.2.2, "Nuclear Enthalpy Rise Hot Channel Factor (F_{AH}^N)";
LCO 3.2.3, "AXIAL FLUX DIFFERENCE (AFD)";
LCO 3.2.5, "Departure from Nucleate Boiling Ratio (DNBR)";
LCO 3.4.1, "RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits"; and
LCO 3.9.1, "Boron Concentration";

- b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:
1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluations Methodology," July 1985.
 2. WCAP-12472-P-A, "BEACON Core Monitoring and Operations Support System," August 1994.
 3. NFSR-0016, "Commonwealth Edison Company Topical Report on Benchmark of PWR Nuclear Design Methods," July 1983.
 4. NFSR-0081, "Commonwealth Edison Company Topical Report on Benchmark of PWR Nuclear Design Methods Using the Phoenix-P and ANC Computer Codes," July 1990.
 5. ComEd letter from D. Saccomando to the Office of Nuclear Reactor Regulation dated December 21, 1994, transmitting an attachment that documents applicable sections of WCAP-11992/11993 and ComEd application of the UET methodology addressed in "Additional Information Regarding Application for Amendment to Facility Operating Licenses-Reactivity Control Systems."

5.6 Reporting Requirements

5.6.5 CORE OPERATING LIMITS REPORT (COLR) (continued)

6. WCAP-16009-P-A, Revision 0, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," January 2005.
 7. WCAP-10079-P-A, "NOTRUMP, A Nodal Transient Small Break and General Network Code," August 1985.
 8. WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using NOTRUMP Code," August 1985.
 9. WCAP-10216-P-A, Revision 1, "Relaxation of Constant Axial Offset Control - F₀ Surveillance Technical Specification," February 1994.
 10. WCAP-8745-P-A, "Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.
 11. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999.
 12. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995, (Westinghouse Proprietary).
 13. WCAP-12610-P-A & CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," July 2006, (Westinghouse Proprietary).
- c. The core operating limits shall be determined such that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems (ECCS) limits, nuclear limits such as SDM, transient analysis limits, and accident analysis limits) of the safety analysis are met; and
- d. The COLR, including any midcycle revisions or supplements, shall be provided upon issuance for each reload cycle to the NRC.



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED
TO AMENDMENT NO. 190 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-72,
AMENDMENT NO. 190 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-77,
AMENDMENT NO. 196 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-37,
AND AMENDMENT NO. 196 TO RENEWED 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 letter to the U.S. Nuclear Regulatory Commission (NRC, the Commission) dated February 23, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16055A149), Exelon Generation Company, LLC (the licensee) requested changes to the facility operating licenses and technical specifications (TSs) for Braidwood Station, Units 1 and 2 (Braidwood), and Byron Station, Unit Nos. 1 and 2 (Byron). The changes would revise TSs 4.2.1, "Fuel Assemblies" and 5.6.5, "Core Operating Limits Report (COLR)" to allow the use of Optimized ZIRLO™ fuel cladding material in Braidwood and Byron and to add WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," (Reference 2), and Addendum 1-A to Topical Report WCAP-12610-P-A and CENPD-404-P-A, "Optimized ZIRLO" (Reference 3), to the list of documents previously reviewed and approved by the NRC.

2.0 REGULATORY EVALUATION

Section 182a. of the Atomic Energy Act of 1954, as amended, requires applicants for nuclear power plant operating licenses to include technical specifications (TSs) as part of the license. The NRC's regulatory requirements related to the content of the TSs are set forth in Title 10 of the Code of Federal Regulations (10 CFR) Section 50.36, "Technical specifications." This regulation requires that TSs include: (1) safety limits, limiting safety system settings and limiting control settings, (2) limiting conditions for operation, (3) surveillance requirements (SRs), (4) design features, and (5) administrative controls.

Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (SRP, NUREG-0800), Section 4.2, "Fuel System Design," provides regulatory guidance for the review of fuel rod cladding materials and the fuel system. In addition, the SRP provides guidance for compliance with the applicable general design criteria (GDC) at 10 CFR Part 50, Appendix A. According to SRP, Section 4.2, the fuel system safety review provides assurance that:

- The fuel system is not damaged as a result of normal operation and anticipated operational occurrences (AOOs),
- Fuel system damage is never so severe as to prevent control rod insertion when it is required,
- The number of fuel rod failures is not underestimated for postulated accidents, and
- Coolability is always maintained.

Appendix A to 10 CFR Part 50 provides GDC that must be considered when developing principle design criteria for a water-cooled nuclear power plant. Section 3.1 of the Braidwood and Byron combined Updated Final Safety Analysis Report (UFSAR) discusses conformance with the GDC. The proposed amendment was evaluated against the following GDC, as incorporated into the Braidwood and Byron licensing basis through the UFSAR.

10 CFR Part 50, Appendix A, GDC 10, "Reactor design," establishes specified acceptable fuel design limits (SAFDLs) that shall not be exceeded during any condition of normal operation, including the effects of AOOs. SAFDLs are established to ensure that the fuel is not damaged, that is, that the fuel rods do not fail and the fuel system dimensions remain within operational tolerances.

10 CFR Part 50, Appendix A, GDC 27, "Combined reactivity control systems capability," relates to the reactivity control system being designed with appropriate margin and, in conjunction with the emergency core cooling system (ECCS), being capable of reliably controlling reactivity changes and cooling the core under postulated accident conditions.

10 CFR Part 50, Appendix A, GDC 35, "Emergency core cooling," relates to providing an ECCS to transfer heat from the reactor core following any loss of reactor coolant at a rate such that: (1) fuel and clad damage that could interfere with continued effective core cooling is prevented and (2) clad metal-water reaction is limited to negligible amounts.

3.0 TECHNICAL EVALUATION

3.1 TS 4.2.1

Braidwood Current TS 4.2.1:

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly, with exceptions as noted below, shall consist of a matrix of Zircaloy or ZIRLO clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO₂) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods or

vacancies for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

Up to 8 AREVA NP Advanced Mark-BW(A) fuel assemblies containing M5 alloy may be placed in nonlimiting Unit 1 core regions for evaluation during Cycles 15, 16, and 17.

Braidwood Proposed Revised TS 4.2.1 (proposed changes in bold):

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly, with exceptions as noted below, shall consist of a matrix of Zircaloy, **ZIRLO®**, or **Optimized ZIRLO™** clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO₂) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods or vacancies for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

Up to 8 AREVA NP Advanced Mark-BW(A) fuel assemblies containing M5 alloy may be placed in nonlimiting Unit 1 core regions for evaluation during Cycles 15, 16, and 17.

Byron Current TS 4.2.1:

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of Zircaloy or ZIRLO clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO₂) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods or vacancies for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

Byron Proposed Revised TS 4.2.1 (proposed changes in bold):

4.2.1 Fuel Assemblies

The reactor shall contain 193 fuel assemblies. Each assembly shall consist of a matrix of Zircaloy, **ZIRLO®**, or **Optimized ZIRLO™** clad fuel rods with an initial composition of natural or slightly enriched uranium dioxide (UO₂) as fuel material. Limited substitutions of zirconium alloy or stainless steel filler rods or vacancies for fuel rods, in accordance with approved applications of fuel rod configurations, may be used. Fuel assemblies shall be limited to those fuel designs that have been analyzed with applicable NRC staff approved codes and methods and shown by tests or analyses to comply with all fuel safety design bases. A limited number of lead test assemblies that have not completed representative testing may be placed in nonlimiting core regions.

The proposed change to TS 4.2.1 adds "Optimized ZIRLO™" to the list of cladding materials in the sentence describing the fuel rods. In Reference 3, the NRC staff approved Optimized ZIRLO™ fuel cladding based upon (1) similarities with standard ZIRLO®, (2) demonstrated material performance, and (3) a commitment to provide irradiated data and validate fuel performance models ahead of burnups achieved in batch applications.

3.1.2 Treatment of Limitations and Conditions for Addendum 1-A to Topical Report WCAP-12610-P-A and CENPD-404-P-A

The NRC staff's safety evaluation (SE) for Addendum 1 to topical report WCAP-12610-P-A and CENPD-404-P-A (Reference 3), contains 10 conditions and limitations. Licensees referencing to Addendum 1-A to topical report WCAP-12610-P-A and CENPD 404-P-A to implement Optimized ZIRLO™ must ensure compliance with the 10 conditions and limitations. The licensee has documented its compliance with these 10 conditions and limitations. The TS 4.2.1 requirement to use NRC-approved codes and methods ensures compliance for future reloads. Each condition and limitation is restated below along with the NRC staff's evaluation of compliance thereto.

3.1.2.1 Condition and Limitation 1

Exemption

Until rulemaking to 10 CFR Part 50 addressing Optimized ZIRLO™ has been completed, implementation of Optimized ZIRLO™ fuel clad requires an exemption from 10 CFR 50.46 and 10 CFR Part 50 Appendix K.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Exelon submitted an exemption request for both Braidwood and Byron in its letter dated February 23, 2016 (Reference 1). The NRC-approved the exemption request by its letter dated June 20, 2016 (ADAMS Accession No. ML16126A032). The NRC staff, therefore, concludes that this condition and limitation has been satisfied.

3.1.2.2 Condition and Limitation 2

Burnup Limit

The fuel rod burnup limit for this approval remains at currently established limits: 62 GWd/MTU for Westinghouse fuel designs and 60 GWd/MTU for CE [Combustion Engineering] fuel designs.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Braidwood and Byron use a Westinghouse fuel design (and not a CE fuel design) and Exelon stated in its letter dated February 23, 2016, that Braidwood and Byron will continue to use a 62 GWd/MTU rod burnup. Also the addition of Addendum 1-A to WCAP-12610-P-A and CENPD 404-P-A to TS 5.6.5.b will require both Braidwood and Byron to maintain a maximum rod burnup of 62 GWd/MTU. Therefore, the NRC staff concludes that this condition and limitation has been satisfied.

3.1.2.3 Condition and Limitation 3

Corrosion Limit

The maximum fuel rod waterside corrosion, as predicted by the best-estimate model, will [satisfy proprietary limits included in the topical report and the proprietary version of the SE] of hydrides for all locations of the fuel rod.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Exelon confirmed in its letter dated February 23, 2016, that the methodologies used for normal reload process will ensure that the maximum fuel rod waterside corrosion limit will be verified to be less than the specified proprietary limits for all fuel rod locations as a normal part of the reload design process. Therefore, the NRC staff concludes that this condition and limitation has been satisfied.

3.1.2.4 Condition and Limitation 4

Conditions on Approved Methodologies

All the conditions listed in previous NRC SE approvals for methodologies used for standard ZIRLO™ and Zircaloy-4 fuel analysis will continue to be met, except that the use of Optimized ZIRLO™ cladding in addition to standard ZIRLO™ and Zircaloy-4 cladding is now approved.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Exelon confirmed in its letter dated February 23, 2016, that future analysis using Optimized ZIRLO™, as required by the reload methodologies listed in TS 5.6.5.b, will continue to meet all

conditions contained within the approved methods. Therefore, the NRC staff concludes that this condition and limitation has been satisfied.

3.1.2.5 Condition and Limitation 5

Application Domain

All methodologies will be used only within the range for which ZIRLO™ and Optimized ZIRLO™ data were acceptable and for which the verifications discussed in Addendum 1 and responses to RAIs [requests for additional information] were performed.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Exelon confirmed in its letter dated February 23, 2016, that the application of Optimized ZIRLO™ will be consistent with the approach accepted in WCAP 12610-P-A and CENPD-404-P-A Addendum 1-A, and that confirmation of these conditions is part of the normal reload design process required by the methodologies in TS 5.6.5.b. Therefore, the NRC staff concludes that this condition and limitation has been satisfied.

3.1.2.6 Condition and Limitation 6

LTA Data

The licensee is required to ensure that Westinghouse has fulfilled the following commitment: Westinghouse shall provide the NRC staff with a letter(s) containing the following information (Based on the schedule described in response to RAI #3):

- a. *Optimized ZIRLO™ LTA [lead test assembly] data from Byron, Calvert Cliffs, Catawba, and Millstone.*
 - i. *Visual*
 - ii. *Oxidation of fuel rods*
 - iii. *Profilometry*
 - iv. *Fuel rod length*
 - v. *Fuel assembly length*
- b. *Using the standard and Optimized ZIRLO™ database including the most recent LTA data, confirm applicability with currently approved fuel performance models (e.g., measured vs. predicted).*

Confirmation of the approved models' applicability up through the projected end of cycle burnup for the Optimized ZIRLO™ fuel rods must be completed prior to their initial batch loading and prior to the startup of subsequent cycles. For example, prior to the first batch application of Optimized ZIRLO™, sufficient LTA data may only be available to confirm the models' applicability up through 45 GWd/MTU. In this example, the licensee would need to confirm the models up through the end of the initial cycle. Subsequently, the licensee would need to confirm the models, based upon the latest LTA data, prior to re-inserting the Optimized ZIRLO™ fuel rods in future cycles. Based upon the LTA schedule, it is expected that this issue may only be applicable to the first few batch implementations since sufficient LTA data up through the burnup limit should be available within a few years.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Westinghouse submitted numerous documents to the NRC to supply the requested information in various stages:

- LTR-NRC-07-1 (Reference 4) – This submittal includes information from the complete Byron LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (1 cycle), Catawba LTA (1 cycle), and Millstone LTA (1 cycle).
- LTR-NRC-07-58 (Reference 5) – This submittal includes information from the complete Byron LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (1 cycle), Catawba LTA (2 cycles), and Millstone LTA (2 cycles).
- LTR-NRC-07-58, Revision 1, (Reference 6) – This submittal includes information from the complete Byron LTA (3 cycles). It also included updated information from the ongoing Calvert Cliffs LTA (1 cycle), Catawba LTA (2 cycles), and Millstone LTA (2 cycles).

- LTR-NRC-08-60 (Reference 7) – This submittal includes information from the complete Byron LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (2 cycle), Catawba LTA (2 cycles), and Millstone LTA (2 cycles).
- LTR-NRC-10-53 (Reference 8) - This submittal includes information from the complete Byron LTA (3 cycles), Catawba LTA (3 cycles), and Millstone LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (3 cycles).
- LTR-NRC-13-6 (Reference 9) – This submittal includes information from the complete Byron LTA (3 cycles), Catawba LTA (3 cycles), Millstone LTA (3 cycles), and Calvert Cliffs LTA (3 cycles).
- LTR-NRC-15-7 (Reference 10) – This submittal provides the responses to RAIs received in response to letter LTR-NRC-13-6 (Reference 9), which was issued to fulfill Conditions 6 and 7 of WCAP-12610- P-A and CENPD-404-P-A, Addendum 1-A (Reference 3).

The LTA measurements show the corrosion rate of the stress-relief annealed (SRA) Optimized ZIRLO™ and partially-re-crystallized annealed (PRXA) Optimized ZIRLO™ to be significantly lower than that of the standard ZIRLO™. Similarly, the measured SRA/PRXA Optimized ZIRLO™ fuel rod growth is also within the predictive capability of the standard ZIRLO™ fuel rod growth model as the measured values are well within the scatter band of the standard ZIRLO™ fuel rod growth database. Based on the measurements and evaluations of LTA data, the NRC staff finds that the licensee has demonstrated acceptable in-reactor performance and that the fuel rod and assembly design calculations remain valid and the Optimized ZIRLO™ fuel will operate within design criteria.

By submitting this information, the models' applicability has been confirmed for burnups up to 62 GWd/MTU for Westinghouse fuels. None of the visual inspections showed anomalies. The measurements of oxidation demonstrated that the oxide thickness of Optimized ZIRLO™ was bounded by that of standard ZIRLO™. The profilometry data demonstrated that the growth of Optimized ZIRLO™ was bounded by that of standard ZIRLO™ and was appropriately bounded by the PAD 4.0 model. The measurements of axial growth demonstrated that the Optimized ZIRLO™ assemblies were within the upper and lower growth bounds. Based on this information, the NRC staff concludes that this condition and limitation is satisfied.

3.1.2.7 Condition and Limitation 7

Cycle Data

The licensee is required to ensure that Westinghouse has fulfilled the following commitment: Westinghouse shall provide the NRC staff with a letter containing the following information (based on the schedule described in response to RAI #11):

- a. Vogtle growth and creep data summary reports.*
- b. Using the standard ZIRLO™ and Optimized ZIRLO™ database including the most recent Vogtle data, confirm applicability with currently approved fuel performance models (e.g., level of conservatism in W rod pressure analysis, measured vs. predicted, predicted minus measured vs. tensile and compressive stress).*

Confirmation of the approved models' applicability up through the projected end of cycle burnup for the Optimized ZIRLO™ fuel rods must be completed prior to their initial batch loading and prior to the startup of subsequent cycles. For example, prior to the first batch application of Optimized ZIRLO™, sufficient LTA data may only be available to confirm the models' applicability up through 45 GWd/MTU. In this example, the licensee would need to confirm the models up through the end of the initial cycle. Subsequently, the licensee would need to confirm the models, based upon the latest LTA data, prior to re-inserting the Optimized ZIRLO™ fuel rods in future cycles. Based upon the LTA schedule, it is expected that this issue may only be applicable to the first few batch implementations since sufficient LTA data up through the burnup limit should be available within a few years.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Westinghouse submitted numerous documents to the NRC to supply the requested information in various stages:

- LTR-NRC-07-1 (Reference 4) – This submittal includes information from the complete Byron LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (1 cycle), Catawba LTA (1 cycle), and Millstone LTA (1 cycle).
- LTR-NRC-07-58 (Reference 5) – This submittal includes information from the complete Byron LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (1 cycle), Catawba LTA (2 cycles), and Millstone LTA (2 cycles).
- LTR-NRC-07-58, Revision 1, (Reference 6) – This submittal includes information from the complete Byron LTA (3 cycles). It also included updated information from the ongoing Calvert Cliffs LTA (1 cycle), Catawba LTA (2 cycles), and Millstone LTA (2 cycles).
- LTR-NRC-08-60 (Reference 7) – This submittal includes information from the complete Byron LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (2 cycle), Catawba LTA (2 cycles), and Millstone LTA (2 cycles).

- LTR-NRC-10-53 (Reference 8) - This submittal includes information from the complete Byron LTA (3 cycles), Catawba LTA (3 cycles), and Millstone LTA (3 cycles). It also included information from the ongoing Calvert Cliffs LTA (3 cycles).
- LTR-NRC-13-6 (Reference 9) – This submittal includes information from the complete Byron LTA (3 cycles), Catawba LTA (3 cycles), Millstone LTA (3 cycles), and Calvert Cliffs LTA (3 cycles).
- LTR-NRC-15-7 (Reference 10) – This submittal provides the responses to RAIs received in response to letter LTR-NRC-13-6 (Reference 9), which was issued to fulfill Conditions 6 and 7 of WCAP-12610- P-A and CENPD-404-P-A, Addendum 1-A (Reference 3).

One of the main objectives of the ongoing Westinghouse creep program is to demonstrate that Optimized ZIRLO™ creep is the same as for standard ZIRLO®, and that the creep in tension is similar to the creep in compression. Westinghouse concludes (Reference 9) that the PAD 4.0 creep model does not extrapolate well to the low temperatures at which the Vogtle capsule operates. However, the PAD 4.0 model provides acceptable results in the high temperature region that is typically limiting for fuel performance analyses. Section 3.3 of Reference 9 summarizes Creep/Growth results based on currently available data for: (1) the irradiation growth and creep of standard ZIRLO® and PRXA Optimized ZIRLO™ and (2) the irradiation creep of standard ZIRLO® under tensile and compressive deviatoric (differential) hoop stresses. The irradiation creep was measured using samples filled with helium gas. The internal gas pressure was either below or above system pressure so that the samples were in either compressive or tensile hoop stress, respectively.

Figures 14-17 of Reference 9 (as amended by Attachment 2 of Reference 10) presents the diameter irradiation creep data for standard ZIRLO®, PRXA Optimized ZIRLO™ and SRA Optimized ZIRLO™ under compressive stress. In response to a staff request (RAI #3a of Reference 10), Westinghouse provided similar irradiation creep data under tensile stress. The measured data show that the diameter irradiation creep of PRXA Optimized ZIRLO™ cladding and SRA standard ZIRLO® cladding are similar under both compression and tension stresses.

Figures 18 to 21 of Reference 9 (as amended by Attachment 2 of Reference 10) present an evaluation of the irradiation creep data for standard ZIRLO® for tensile and compressive deviatoric hoop stresses. In response to a staff request (RAI #4 of Reference 10), Westinghouse provided similar irradiation creep data for PRXA Optimized ZIRLO™. All of these figures show that the data are very consistent between stress levels, the strain behavior is linear as a function of the deviatoric (differential) hoop stress, and the regression fits to the data approximately exhibit zero strain when the deviatoric hoop stress is zero, demonstrating that compressive and tensile creep are equivalent.

Section 4.0 of Reference 9 describes the analytical evaluations relating the measured Vogtle and other ZIRLO™ creep and growth profilometry data to the Westinghouse licensed fuel performance models (PAD 4.0 and FATES3B) to assess the ability of the existing creep models to predict the data. In response to staff concerns regarding the comparison of data trends based on deviatoric stress and model predictions based on total hoop stress (RAI #5 of Reference 10), Westinghouse stated that limitations with the existing creep model would be

addressed in PAD 5 (currently under review). In response to RAI #7 of Reference 10, Westinghouse states that while the existing creep models may under predict the data under low temperature conditions, these same models provide acceptable results in the high temperature regions which is typically limiting for fuel performance analyses.

Based on the above, the NRC staff concludes that this condition and limitation has been satisfied.

3.1.2.8 Condition and Limitation 8

Yield Strength

The licensee shall account for the relative differences in unirradiated strength (YS and UTS) between Optimized ZIRLO™ and standard ZIRLO™ in cladding and structural analyses until irradiated data for Optimized ZIRLO™ have been collected and provided to the NRC staff.

- a. *For the Westinghouse fuel design analyses:*
 - i. *The measured, unirradiated Optimized ZIRLO™ strengths shall be used for BOL [beginning of life] analyses.*
 - ii. *Between BOL up to a radiation fluence of 3.0×10^{21} n/cm² [neutron per centimeter square] ($E > 1$ MeV (energy) [greater than 1 mega-electron volt]), pseudo-irradiated Optimized ZIRLO™ strength set equal to linear interpolation between the following two strength level points: At zero fluence, strength of Optimized ZIRLO™ equal to measured strength of Optimized ZIRLO™ and at a fluence of 3.0×10^{21} n/cm² ($E > 1$ MeV), irradiated strength of standard ZIRLO™ at the fluence of 3.0×10^{21} n/cm² ($E > 1$ MeV) minus 3 ksi.*
 - iii. *During subsequent irradiation from 3.0×10^{21} n/cm² up to 12×10^{21} n/cm², the differences in strength (the difference at a fluence of 3×10^{21} n/cm² due to tin content) shall be decreased linearly such that the pseudo-irradiated Optimized ZIRLO™ strengths will saturate at the same properties as standard ZIRLO™ at 12×10^{21} n/cm².*
- b. *For the CE fuel design analyses, the measured, unirradiated Optimized ZIRLO™ strengths shall be used for all fluence levels (consistent with previously approved methods).*

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Exelon stated in its letter dated February 23, 2016, that future analysis of Optimized ZIRLO™ will use the yield strength and ultimate tensile strength as modified per Conditions 8.a.i, 8.a.ii, and 8.a.iii, until such time as the irradiated data for Optimized ZIRLO™ cladding strengths have been collected and accepted by the NRC and that this is confirmed as part of the normal reload design process as required by the methodologies listed in TS 5.6.5.b. Therefore, the NRC staff concludes that this condition and limitation is satisfied.

Braidwood and Byron use a Westinghouse fuel design; therefore, the NRC staff concludes that Condition and Limitation 8.b does not apply.

3.1.2.9 Condition and Limitation 9

LOCBART or STRIKIN-II early PCT

As discussed in response to RAI #21 (Reference 3), for plants introducing Optimized ZIRLO™ that are licensed with LOCBART or STRIKIN-II and have a limiting PCT that occurs during blowdown or early reflood, the limiting LOCBART or STRIKIN-II calculation will be rerun using the specified Optimized ZIRLO™ material properties. Although not a condition of approval, the NRC staff strongly recommends that, for future evaluations, Westinghouse update all computer models with Optimized ZIRLO™ specific material properties.

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Braidwood and Byron are not licensed with LOCBART or STRIKIN-II. Therefore, the NRC staff concludes that this condition and limitation does not apply.

3.1.2.10 Condition and Limitation 10

Locked Rotor PCT

Due to the absence of high temperature oxidation data for Optimized ZIRLO™, the Westinghouse coolability limit on PCT during the locked rotor event shall be [proprietary limits included in the topical report and the proprietary version of the SE].

SE for WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A

Exelon stated in its letter dated February 23, 2016, that the peak cladding temperature (PCT) limit during the locked rotor event will be assessed relative to the Westinghouse Optimized ZIRLO™ cladding PCT temperature and that this is confirmed as part of the normal reload design process. Therefore, the NRC staff concludes that this condition and limitation is satisfied.

3.1.3 Because the NRC staff has approved the use of Optimized ZIRLO™ cladding in References 2 and 3, and the licensee has satisfied the conditions and limitations specified therein as discussed above, the NRC staff concludes that the Braidwood revised TS 4.2.1, and the Byron revised TS 4.2.1, is acceptable.

The NRC staff, in Reference 3, references GDC 10, GDC 27, and GDC 35 in its regulatory evaluation and states:

The NRC staff reviewed the effects of Optimized ZIRLO™ using the appropriate fuel design requirements of SRP 4.2 and 10 CFR Part 50, Appendix A, General Design Criteria and found that the TR [Topical Report] provided reasonable

assurance that under both normal and accident conditions, Westinghouse and CE fuel assembly designs implementing Optimized ZIRLO™ fuel cladding would be able to safely operate and comply with NRC regulations.

Based on the licensee satisfying the conditions and limitations as described above and the NRC statements in Reference 3, the NRC staff concludes that the guidance in the SRP 4.2 and the requirements in 10 CFR Part 50, Appendix A, GDCs 10, 27, and 35 are met. The NRC staff also concludes that, since the TS changes revise the design features for fuel assemblies listed within the reactor core TSs and the change to TS 5.6.5 revises administrative controls, the requirements of 10 CFR 50.36 are met.

3.2 TS 5.6.5, "Core Operating Limits Report (COLR)"

The Braidwood and Byron TS page 5.6-3 is proposed to be replaced because of repagination of TS 5.6.5.b.5 from page 5.6-4 to page 5.6-3. The repagination is administrative in nature and is, therefore, acceptable. There are no margin marks on page 5.6-3 because the amendment makes no changes to the TS contained on the page.

Braidwood and Byron current TS 5.6.6.b.11

11. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999;

Braidwood and Byron proposed revised TS 5.6.6.b.11 (changes in bold)

11. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal- Hydraulic Safety Analysis," October 1999.

Braidwood and Byron proposed added TS 5.6.6.b.12 and 13

12. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995. (Westinghouse Proprietary).
13. WCAP-12610-P-A & CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," July 2006. (Westinghouse Proprietary).

The NRC staff finds that the proposed change (i.e., from a semicolon to period) to TS 5.6.6.b.11 is administrative in nature and, therefore, concludes that it is acceptable.

The proposed additions of TS 5.6.6.b.12 and 13 are acceptable because the NRC staff has approved, in Reference 3, the topical reports proposed to be added.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State official was notified of the proposed issuance of the amendment on June 20, 2016. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendment involves 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 on May 10, 2016 (81 FR 28897), that the amendment involves no significant hazards consideration, and there has been no public comment on such finding. Accordingly, the amendment meets 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 amendment.

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.

7.0 REFERENCES

1. P.R. SIMPSON (EXELON) to U.S. NRC, "License Amendment Request and 10 CFR 50.12 Exemption Request for the use of Optimized ZIRLO™ Fuel Rod Cladding," RS-16-034, ADAMS Accession No. ML16055A149 (February 23, 2016)
2. WESTINGHOUSE ELECTRIC COMPANY, "VANTAGE+ Fuel Assembly Reference Core Report," WCAP-12610-P-A, ADAMS Accession No. ML090720988 (April 1995)
3. WESTINGHOUSE ELECTRIC COMPANY, "Optimized ZIRLO™," WCAP-12610-P-A and CENPD-404-P-A, Addendum I-A, ADAMS Accession No. ML062080576 (July 2006)
4. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "SER Compliance with WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," LTR-NRC-07-1, ADAMS Accession Nos. ML07010038 (Submittal Letter), ML070100388 (Non-Proprietary Attachment), ML070100389 (Proprietary Attachment) (January 4, 2007)
5. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "SER Compliance with WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," LTR-NRC-07-58, ADAMS Accession Nos. ML073130556 (Submittal Letter), ML073130560 (Non-Proprietary Attachment), ML073130562 (Proprietary Attachment) (November 6, 2007)

6. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "SER Compliance with WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," LTR-NRC-07-58 Rev 1, ADAMS Accession Nos. ML080390451 (Submittal Letter), ML080390452 (Non-Proprietary Attachment), ML080390453 (Proprietary Attachment) (December 30, 2008)
7. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "SER Compliance with WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," LTR-NRC-08-60, ADAMS Accession Nos. ML090080380 (Submittal Letter), ML090080381 (Non-Proprietary Attachment), ML090080382 (Proprietary Attachment) (February 5, 2008)
8. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "SER Compliance with WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," LTR-NRC-10-43, ADAMS Accession Nos. ML102140213 (Submittal Letter), ML102140214 (Non-Proprietary Attachment), ML102140215 (Proprietary Attachment) (July 26, 2010)
9. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "SER Compliance with WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," LTR-NRC-13-6, ADAMS Accession Nos. ML13070A188 (Submittal Letter), ML13070A189 (Non-Proprietary Attachment), ML13070A190 (Proprietary Attachment) (February 25, 2013)
10. Letter from J. A. GRESHAM (Westinghouse) to U.S.NRC, "Submittal of Responses to Draft RAIs and Revisions to Select Figures in LTR-NRC-13-6 to Fulfill Conditions 6 and 7 of the Safety Evaluation for WCAP-12610-P-A & CENPD-404-P-A Addendum 1-A," LTR-NRC-15-7, ADAMS Accession Nos. ML15051A427 (Submittal Letter), ML15051A428 (Non-Proprietary Attachment 1), ML15051A429 (Non-Proprietary Attachment 2), ML15051A430 (Proprietary Attachment 1), ML15051A431 (Proprietary Attachment 2) (February 9, 2015)

Principal Contributor: J. S. Kaizer

Date of issuance: August 1, 2016

B. Hanson

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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 Branch III-2
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. 190 to NPF-72
2. Amendment No. 190 to NPF-77
3. Amendment No. 196 to NPF-37
4. Amendment No. 196 to NPF-66
5. Safety Evaluation

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NAME	JWiebe	SRohrer	JDean*	AKlein	JWachutka	GEMiller (A)	JWiebe
DATE	6/30/2016	6/28/2016	4/12/2016	6/30/2016	7/14/2016	8/1/2016	8/1/2016

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