September 22, 2003

Mr. John L. Skolds, President
Exelon Nuclear
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNITS 1 AND 2, EXEMPTION FROM THE REQUIREMENTS OF 10 CFR 50.44, 10 CFR 50.46 AND 10 CFR PART 50 APPENDIX K (TAC NOS. MB7371 and MB7372)

Dear Mr. Skolds:

The Commission has approved the enclosed exemption from specific requirements of Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 50.44, 50.46, and Appendix K for the Byron Station, Units 1 and 2. This action is in response to your letter of January 17, 2003, as supplemented by letter dated March 24, 2003, that submitted additional information requested for the above exemption to clarify that non-proprietary information that may be placed in the public domain.

The staff concludes that Exelon Generation Company, LLC has achieved the underlying purpose of the applicable regulations including 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50, and thus approves an exemption from the requirements of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50 for the ZIRLO (LT-2) clad fuel rods for Byron Station Unit 1 Cycle 13.

The basis for approving the exemption is contained in the enclosed Safety Evaluation. A copy of the exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

/RA/

Mahesh Chawla, Project Manager, Section 2
Project Directorate 3
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos.: STN 50-454 and STN 50-455

Enclosures: As stated

cc w/enclosure: See next page

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Byron Station Units 1 and 2

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7590-01-P

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNITS 1 AND 2

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

EXEMPTION

1.0 BACKGROUND

The Exelon Generation Company, LLC (the licensee) is the holder of Facility Operating License Nos. NPF-37 and NPF-66 which authorizes operation of the Byron Station, Units 1 and 2. The licenses provide, among other things, that the facility is subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

The facility consists of two pressurized-water reactors located in Ogle County in Illinois.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, requires, among other items, that each boiling or pressurized light-water nuclear power reactor fueled with oxide pellets within cylindrical zircaloy or ZIRLO cladding, must, as provided in paragraphs (b) through (d) of 10 CFR 50.44, include means for control of hydrogen gas that may be generated, following a postulated loss-of-coolant accident (LOCA) by:

(1) Metal-water reaction involving the fuel cladding and the reactor coolant.

(2) Radiolytic decomposition of the reactor coolant, and

(3) Corrosion of metals.

Section 50.46 of Title 10 of the *Code of Federal Regulations*, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors," requires, among other items, that each boiling or pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical zircaloy or ZIRLO cladding, must be provided with an emergency core cooling system (ECCS) that must be designed so that its calculated cooling performance following postulated LOCAs conforms to the criteria set forth in paragraph (b) of 10 CFR 50.46. Section 50.46 also requires that ECCS cooling performance must be calculated in accordance with an acceptable evaluation model and must be calculated for a number of postulated LOCAs of different sizes, locations, and other properties sufficient to provide assurance that the most severe postulated LOCAs are calculated. Section 50.46 provides further that an acceptable evaluation model may be developed in conformance with the features of 10 CFR Part 50, Appendix K models.

Appendix K to Part 50 of Title 10 of the *Code of Federal Regulations*, "ECCS Evaluation Models," requires, among other items, that the rate of energy release, hydrogen generation, and cladding oxidation from the metal/water reaction shall be calculated using the Baker-Just equation.

In summary, 10 CFR 50.44, 10 CFR 50.46, and 10 CFR Part 50, Appendix K, make no provisions for use of fuel rods clad in a material other than Zircaloy or ZIRLO. The licensee has requested the use of a limited number of "lower tin" ZIRLO clad replacement fuel rods in one lead test assembly (LTA) with a tin composition that is less than the licensing basis for ZIRLO tin composition, as defined in Westinghouse design specifications.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant an exemption from the requirements of 10 CFR Part 50 only if (1) the exemption is authorized by law, will not present an undue risk to public health or

safety, and is consistent with the common defense and security; and (2) special circumstances are present. Special circumstances are present if application of the regulation is not necessary to achieve the underlying purpose of the rule.

The licensee here requests an exemption in order to use newly developed low tin ZIRLO that is an improved version of the ZIRLO material, and is not described in WCAP-12610-P-A, “VANTAGE+ Fuel Assembly Reference Core Report," which describes the use of ZIRLO clad fuel. The staff examined the licensee’s rationale to support the exemption request(s) and, for the reasons set forth below, concludes that the licensee would meet the underlying purpose of 10 CFR 50.44, 50.46 and Part 50, Appendix K.

The underlying purpose of 10 CFR 50.44 is to ensure that means are provided for the control of hydrogen gas that may be generated following a LOCA. The licensee has provided means for controlling hydrogen gas and has previously considered the potential for hydrogen gas generation stemming from a metal-water reaction. The LTA rods containing the lower tin ZIRLO (LT-2) cladding are similar in chemical composition to zircaloy cladding. Accordingly, previous calculations of hydrogen production resulting from a metal-water reaction will not be significantly changed. As such, application of 10 CFR 50.44 is not necessary for the licensee to achieve its underlying purpose in these circumstances.

The underlying purpose of 10 CFR 50.46, and 10 CFR Part 50, Appendix K, is to establish requirements for the calculation of ECCS performance. The ECCS performance requirements include peak cladding temperature, maximum cladding oxidation, hydrogen generation, and coolable geometry. With respect to 10 CFR 50.46, the licensee has previously performed a LOCA safety analysis using the approved Westinghouse methodology including the Byron Station ECCS Model Safety Analysis of Record for LTAs of lower tin ZIRLO (LT-1) cladding. The unique features of the LTAs were evaluated for effects on the LOCA analysis. The result showed that the Byron Station ECCS Model Safety Analysis of Record remained

bounding for those LTAs. The staff recognizes that the current LTAs will be located at non-limiting core locations, and the ZIRLO (LT-2) is very similar to the approved ZIRLO and the previously exempted ZIRLO (LT-1) in chemical composition and mechanical behavior. Accordingly, the currently approved methodology for analyzing ECCS performance is acceptable to apply for the low tin ZIRLO (LT-2) LTAs, as is further discussed below with respect to the Baker-Just equation. As also discussed below, results of comparative LOCA calculations with the same plant operating parameters will be performed in the reload analysis for Cycle 13 to verify that the current ECCS Model Safety Analysis of Record remains bounding for these four LTAs for Byron Station Unit 1 Cycle 13.

Paragraph I.A.5 of Appendix K to 10 CFR Part 50 states that the rates of energy, hydrogen concentration, and cladding oxidation from the metal-water reaction shall be calculated using the Baker-Just equation. Since the Baker-Just equation presumes the use of zircaloy clad fuel, strict application of the rule would not permit use of the equation for the ZIRLO (LT-2) cladding for determining acceptable fuel performance. The underlying intent of this portion of the Appendix K, however, is to ensure that analysis of fuel response to LOCAs is conservatively calculated. Due to the similarities in the chemical composition of the ZIRLO (LT-2) and zircaloy, the application of the Baker-Just equation in the analysis of the improved ZIRLO (LT-2) clad fuel will conservatively bound all post-LOCA scenarios. Thus, application of Appendix K, Paragraph I.A.5, is not necessary for the licensee to achieve the underlying purpose of the rule in these circumstance.

According to the submittal, the licensee will perform reload analysis to demonstrate adequate ECCS performance, and show that the LTAs do not have a significant impact upon the analysis for Byron Station Unit 1. In the Cycle 13 reload analyses, the licensee will verify that the predicted peak cladding temperature of the LTAs are significantly lower than that predicted for the resident fuel. The licensee will also verify that the Baker-Just equation

conservatively predicts local cladding oxidation of the LTAs of only a few percent. Also, the licensee will verify that maximum hydrogen generation is unchanged with the inclusion of the LTAs, and the coolable geometry is maintained following a LOCA. As such, application of 10 CFR 50.46 and 10 CFR Part 50, Appendix K is not necessary to achieve their underlying purposes in these circumstances.

To summarize, based on the previously acceptable performance of the LTAs in Byron Station Units 1 and 2, the staff concludes that the licensee has demonstrated that the LTAs will perform adequately under LOCA conditions, and thus the LTAs are acceptable for operation in Byron Station Unit 1 Cycle 13.

Therefore, application of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50 is not necessary to achieve their underlying purposes and that special circumstances are present. Thus, it is acceptable to grant an exemption, pursuant to 10 CFR 50.12(a)(2), from the requirements of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50 for the irradiation of the lower tin ZIRLO (LT-2) clad fuel rods in Byron Station Unit 1 during Cycle 13.

4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Also, special circumstances are present. Therefore, the Commission hereby grants Exelon Generation Company, LLC, an exemption from the requirements of 10 CFR 50.44, 10 CFR 50.46, and 10 CFR Part 50, Appendix K, for irradiation of low tin ZIRLO (LT-2) clad fuel rods in Byron Station Unit 1 during Cycle 13.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment (68 FR 54246).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 22nd day of September, 2003.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Eric J. Leeds, Deputy Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO LEAD TEST ASSEMBLY EXEMPTION

EXELON GENERATION COMPANY

BYRON STATION UNITS 1 AND 2

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

1.0 INTRODUCTION

By letter dated January 17, 2003, as supplemented by letter dated March 24, 2003, Exelon Generation Company (EGC), the licensee, submitted a request for an exemption with respect to four lead test assemblies (LTAs) for Byron Station Unit 1. The supplement dated March 24, 2003, provided additional information to clarify non-proprietary information that may be placed in the public domain.

The licensee requested an exemption from the requirements of Sections 50.44, 50.46, and Appendix K of Title 10 of the *Code of Federal Regulations* (10 CFR) to use a limited number of newly developed low tin ZIRLO clad fuel rods in one of the four planned LTAs for Byron Unit 1 during Cycle 13. The newly developed low tin ZIRLO is a new version of the ZIRLO material, and is not described in WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Reports," which describes the use of ZIRLO clad fuel. Irradiation of these fuel assemblies will provide data on fuel and material performance to support the high burnup fuel program.

2.0 REGULATORY EVALUATION

By letters dated February 26, 1999, the staff approved an exemption for two LTAs that contained a low tin version of ZIRLO, manufactured by Westinghouse Electric Company to be irradiated in Byron Unit 1. The exemption was necessary because the tin content in the LTAs was below the tin content for ZIRLO, specified in WCAP-12610-P-A, as then approved. The licensee designated this version of ZIRLO as ZIRLO (LT-1). Recently Westinghouse developed another version of ZIRLO with even lower tin content, which was designated as ZIRLO (LT-2), to be irradiated in Byron Unit 1 during Cycle 13. The licensee requests an exemption for using ZIRLO (LT-2) clad fuel rods. The licensee proposes to irradiate four LTAs in Byron Unit 1 during Cycle 13. The four LTAs include one LTA containing ZIRLO (LT-2) clad fuel rods, one LTA containing ZIRLO (LT-1) clad fuel rods, and two LTAs with standard ZIRLO clad fuel rods.

The regulation in 10 CFR 50.44, "Standards for combustible gas control system in light-water-cooled power reactors," specifies requirements for the control of hydrogen gas generated after a postulated loss-of-coolant accident (LOCA) for reactors fueled with zircaloy or ZIRLO cladding. 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light water nuclear power reactors," contains acceptance criteria for emergency core cooling

systems (ECCSs) for reactors fueled with zircaloy or ZIRLO cladding. In addition, Appendix K to 10 CFR Part 50, "ECCS Evaluation Models," requires that the Baker-Just equation be used to predict the rates of energy release, hydrogen concentration, and cladding oxidation from the metal-water reaction. However, the Baker-Just equation assumes the use of zircaloy clad fuel. Thus, an exemption from the requirements of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50 is needed for Byron Unit 1 to irradiate the LTA that includes fuel rods clad with ZIRLO (LT-2) material.

3.0 TECHNICAL EVALUATION

3.1 Mechanical Design

The licensee performed mechanical design analyses of the LTAs using the same methodology approved for the VANTAGE+ fuel design as described in WCAP-12610-P-A. The design analyses included material properties, corrosion, and thermal creep. The material properties of ZIRLO (LT-2) cladding are very similar to those of the approved ZIRLO cladding since there are only slight variations in the tin content. The licensee determined that the ZIRLO (LT-2) cladding had better corrosion performance than the ZIRLO (LT-1) or ZIRLO cladding, and compatible thermal creep to the ZIRLO or zircaloy-4 cladding.

Low-tin ZIRLO (LT-2) is very similar to the approved ZIRLO and previously exempted ZIRLO(LT-1) materials in chemical composition and mechanical properties. Accordingly, the currently approved methodology is acceptable to apply to the low-tin ZIRLO (LT-2) LTAs. Based on the previous irradiation performance of the similar LT-1 clad LTAs and acceptable analyses, the staff concludes that the mechanical design of the LTAs clad with low-tin ZIRLO (LT-2) is acceptable for Byron 1 during Cycle 13.

3.2 Nuclear Design

Previously, the licensee has performed nuclear design analyses using the approved reload methodology WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," for the ZIRLO (LT-1) LTAs. The licensee intends to use the same reload methodology to analyze the ZIRLO (LT-2) clad fuel rods. The licensee expects similar results for these four LTAs. The licensee states that the LTAs will not be positioned in the highest power locations. The licensee determined that the LTA design features will have an insignificant impact on the overall core nuclear design. The licensee will verify this conclusion in the reload analysis.

Since low-tin ZIRLO is very similar to the ZIRLO (LT-1) and approved ZIRLO materials in chemical composition and neutronic properties, it should not significantly affect the reload methodology. Accordingly, the currently approved methodology is acceptable to apply to the low-tin ZIRLO (LT-2) LTAs. Based on the approved methodology and previously acceptable analyses, the staff concludes that the LTA nuclear design is acceptable for Byron 1 during Cycle 13.

3.3 Thermal-Hydraulic Design

The licensee performed thermal-hydraulic analyses using the approved Westinghouse methodology for the LTAs. The design analyses covered the LTA impact on the resident fuel including departure from nucleate boiling (DNB), pressure drop, assembly lift, and lateral flow.

The results show that the resident fuel analyses will bound the LTA performance. Thus, the licensee assures that implementation of the LTAs will have no impact on the thermal-hydraulic design of the resident fuel. The licensee will verify this conclusion in the reload analysis.

Low-tin ZIRLO (LT-2) is very similar to the approved ZIRLO and previously exempted ZIRLO(LT-1) materials in chemical composition and mechanical properties. Accordingly, the currently approved methodology is acceptable to apply to the low-tin ZIRLO (LT-2) LTAs. Based on the approved methodology and conservative analyses, the staff concludes that the LTA thermal-hydraulic design is acceptable for Byron 1 during Cycle 13.

3.4 Non-LOCA Transients

The licensee performed non-LOCA transient safety analyses to assess the impact of the LTAs in Chapter 15 of the Updated Final Safety Analysis Report. Since the LTAs are geometrically identical to the current resident fuel and there are insignificant changes from either ZIRLO (LT-1) or ZIRLO (LT-2) to the approved ZIRLO, the current Byron Station Transient Safety Analysis of Record will remain bounding for the four LTAs. In the reload analysis, the licensee will verify this conclusion for non-LOCA transients.

Based on the conservative analyses and similar design features, the staff concludes that the LTAs will not violate safety limits including DNB, cladding temperature, and system pressure for Byron 1 during Cycle 13.

3.5 LOCA Analysis and ECCS Exemption

Pursuant to 10 CFR 50.12(a), the Commission may grant an exemption from the requirements of 10 CFR Part 50 only if (1) the exemption is authorized by law, will not present an undue risk to public health or safety, and is consistent with the common defense and security; and (2) special circumstances are present. Special circumstances are present if application of the regulation in the particular circumstances would not serve the underlying purpose of the rule, or is not necessary to achieve the underlying purpose of the rule.

The underlying purpose of 10 CFR 50.44 is to ensure that means are provided for the control of hydrogen gas that may be generated following a LOCA. The licensee has provided means for controlling hydrogen gas and has previously considered the potential for hydrogen gas generation stemming from a metal-water reaction. The LTA rods containing the ZIRLO (LT-2) cladding are similar in chemical composition to zircaloy cladding. Accordingly, the previous calculations of hydrogen production resulting from a metal-water reaction will not be significantly changed. The licensee will verify this conclusion in the reload analysis. As such, application of 10 CFR 50.44 is not necessary for the licensee to achieve its underlying purpose in these circumstances.

The underlying purpose of 10 CFR 50.46 is to establish acceptance criteria for ECCS performance. The licensee has previously performed a LOCA safety analysis using the approved Westinghouse methodology including the Byron Station ECCS Model Safety Analysis of Record for LTAs of ZIRLO (LT-1) cladding. The unique features of the LTAs were evaluated for effects on the LOCA analysis. The result showed that the Byron Station ECCS Model Safety Analysis of Record remained bounding for those LTAs. The staff recognizes that the current LTAs will be located at non-limiting core locations, and the ZIRLO (LT-2) is very similar

to the approved ZIRLO and the previously exempted ZIRLO (LT-1) in chemical composition and mechanical behavior. Accordingly, the currently approved methodology for analyzing ECCS performance is acceptable to apply for the low-tin ZIRLO(LT-2) LTAs, as is further discussed below with respect to the Baker-Just equation. As is also discussed below, results of comparative LOCA calculations with the same plant operating parameters will be performed in the reload analysis for Cycle 13 to verify that the current ECCS Model Safety Analysis of Record remains bounding for these four LTAs for Byron 1 during Cycle 13. The licensee will verify this conclusion in the reload analysis. Thus, application of 10 CFR 50.46 is not necessary for the licensee to achieve its underlying purpose in these circumstances.

Paragraph I.A.5 of Appendix K to 10 CFR Part 50 states that the rates of energy, hydrogen concentration, and cladding oxidation from the metal-water reaction shall be calculated using the Baker-Just equation. Since the Baker-Just equation presumes the use of zircaloy clad fuel, strict application of the rule would not permit use of the equation for the ZIRLO (LT-2) cladding for determining acceptable fuel performance. The underlying intent of this portion of the Appendix K, however, is to ensure that analysis of fuel response to LOCAs is conservatively calculated. Due to the similarity in the chemical composition of ZIRLO (LT-2) and zircaloy, the application of the Baker-Just equation in the analysis of ZIRLO (LT-2) clad fuel rods will conservatively bound all post-LOCA scenarios. The licensee will verify this conclusion in the reload analysis. Thus, application of Appendix K, Paragraph I.A.5 is not necessary for the licensee to achieve its underlying purpose in these circumstances.

According to the submittal, the licensee will perform reload analysis to demonstrate adequate ECCS performance, and show that the LTAs do not have a significant impact upon the analysis for Byron Station 1. Because the LTAs have low reactivity, the current analyses will remain bounding for them. In the reload analysis, the licensee will verify that the peak cladding temperature of the LTAs will be lower than that of the resident fuel. Using the Baker-Just equation, the licensee will confirm that the local cladding oxidation of the LTAs will be conservatively predicted. Also, the licensee will confirm that the maximum hydrogen generation will be unchanged with the inclusion of the LTAs. Therefore, the coolable geometry is maintained following a LOCA. As such, application of 10 CFR 50.46 and 10 CFR Part 50, Appendix K is not necessary for the licensee to achieve their underlying purposes in these circumstances.

The LTAs meet the same design bases as the resident fuel for the Byron Station 1 Cycle 13 core. No safety limits or setpoints have been altered as a result of the use of the LTAs. The LTAs will be placed in core locations that will not experience the most limiting power peaking during the aforementioned operating cycle. The ZIRLO (LT-2) cladding has been tested for corrosion resistance, tensile and burst strength, and creep characteristics. The results indicate that ZIRLO (LT-2) clad fuel rods meet all the necessary regulations and will perform satisfactorily as do the previously approved fuel rods.

The licensee has completed LTA irradiation performance during previous cycles. Based on the previously acceptable performance in Byron Station, Units 1 and 2, and the above evaluation, the staff concludes that the licensee has demonstrated that the LTAs will perform adequately under LOCA conditions, and thus the LTAs are acceptable for operation in Byron Station 1 during Cycle 13. Based on the above, the staff concludes that special circumstances are present, and that it is acceptable to grant an exemption from the requirements of

10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR Part 50 for the use of a LTA including ZIRLO (LT-2) clad fuel rods in Byron Station Unit 1.

4.0 CONCLUSION

The staff has reviewed the licensee request of proposed exemption for the use of four LTAs including the ZIRLO (LT-2) cladding. Based on the staff evaluation, as set forth above, the staff concludes that application of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR 50 is not necessary for the licensee to achieve their underlying purposes such that special circumstances are present. In addition, the staff has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not present an undue risk to the public health and safety, and is consistent with the common defense and security. Thus, the staff approves an exemption from the requirements of 10 CFR 50.44, 10 CFR 50.46, and Appendix K to 10 CFR 50 for ZIRLO (LT-2) clad fuel rods for Byron Unit 1 during Cycle 13.

Principal Contributor: Shih-Liang Wu

Date: September 22, 2003