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U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Byron Station, Unit 2
Renewed Facility Operating License No. NPF-66
NRC Docket No. 50-455

Subject: Supplement to License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies

Reference: Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies," dated March 8, 2018

In the Referenced letter, Exelon Generation Company, LLC, (EGC) requested an amendment to Renewed Facility Operating License No. NPF-66 for Byron Station, Unit 2. The proposed change would add a License Condition to Appendix C, "Additional Conditions," of the Byron Station Unit 2 Operational License that authorizes the use of a limited number of Accident Tolerant Fuel (ATF) Lead Test Rods (LTRs) in two Lead Test Assemblies (LTAs) during Byron Station Unit 2, Cycles 22, 23, and 24.

The LTR design described in the March 8, 2018 EGC submittal states that the uranium silicide (U_3Si_2) pellets in each rod will be enclosed in a capsule within a sealed segmented rod of approximately one foot in length, and that the segmented rod is inserted into a standard fueled rod to make up part of the normal-length fuel rod. Subsequently the LTR design was changed to eliminate the capsule in order to improve safety and to reduce complexity of manufacturing and analysis. Additionally, the make-up of the LTA containing the ADOPT™ LTRs was revised to eliminate the use of the ADOPT™ pellets with standard Optimized ZIRLO™ clad and only use the ADOPT™ pellets with the coated Optimized ZIRLO™ clad. The technical analysis approach of the specific changes from the previous design and the associated core design impacts are provided in the attached supplement to the March 8, 2018 submittal.

EGC has reviewed the information supporting the No Significant Hazards Consideration and the Environmental Consideration that was previously provided to the NRC in the March 8, 2018 submittal. The modification of the LTR described in this submittal does not affect the conclusion that the proposed license amendment does not involve a significant hazards consideration. This additional information also does not affect the conclusion that neither an environmental

impact statement nor an environmental assessment needs to be prepared in support of the proposed amendment.

In accordance with 10 CFR 50.91, "Notice for public comment; State consultation," paragraph (b), EGC is notifying the State of Illinois of this supplement to the March 8th application for license amendment by transmitting a copy of this letter and its attachment to the designated State of Illinois official.

There are no regulatory commitments contained in this letter. Once approved, the amendment shall be implemented within 30 days. Should you have any questions concerning this letter, please contact Ms. Rebecca L. Steinman at (630) 657-2831.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 2nd day of July 2018.

Respectfully,

David M. Gullott
Manager – Licensing
Exelon Generation Company, LLC

Attachment: Evaluation of LTR Modification on Proposed Change

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector, Byron Station
Illinois Emergency Management Agency – Division of Nuclear Safety

ATTACHMENT 1
Evaluation of LTR Modification on Proposed Change

Subject: Supplement to License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies

ATTACHMENT 1
Evaluation of LTR Modification on Proposed Change

1.0 SUMMARY DESCRIPTION

By letter dated March 8, 2018 (Reference 6.1) Exelon Generation Company, LLC, (EGC) requested an amendment to Renewed Facility Operating License No. NPF-66 for Byron Station, Unit 2. The proposed change would add a License Condition to Appendix C, "Additional Conditions," of the Byron Station Unit 2 Operational License that authorizes the use of a limited number of Accident Tolerant Fuel (ATF) Lead Test Rods (LTRs) in two Lead Test Assemblies (LTAs) during Byron Station Unit 2, Cycles 22, 23, and 24.

The LTR design described in Reference 6.1 states that the uranium silicide (U_3Si_2) pellets in each rod will be enclosed in a capsule within a sealed segmented rod of approximately one foot in length, and that the segmented rod is inserted into a standard fueled rod to make up part of the normal-length fuel rod. Continued development of the Byron Accident Tolerant Fuel (ATF) program has resulted in a modification to the rod design to improve safety and to reduce complexity of manufacturing and analysis. In the modified LTR design, the uranium silicide pellets will be enclosed in a sealed Optimized ZIRLO™ clad segment with the segment positioned between two solid Zircaloy bars to constitute the full-length rod.

Additionally, the make-up of the LTA containing the ADOPT™ LTRs was revised to eliminate the use of the ADOPT™ pellets with standard Optimized ZIRLO™ clad and only use the ADOPT™ pellets with the coated Optimized ZIRLO™ clad [1]. This change is due to the higher pellet density of the ADOPT™ fuel which results in higher power when compared to uranium dioxide pellets. To minimize this power increase, all ADOPT™ pellets will be placed in coated rods because chromium is a light neutron absorber.

The evaluation contained in this supplement discusses the impact of the modified LTR design on the previous technical justification and regulatory basis supporting the conclusion that inserting the subject LTAs, including the described modifications, into the Byron Unit 2 core during Cycles 22, 23, and 24 can be conducted in a safe manner. It is expected that all applicable limits (e.g., fuel thermal mechanical limits, core thermal hydraulic limits, Emergency Core Cooling Systems limits, nuclear limits such as Shutdown Margin, transient analysis limits and accident analysis limits) associated with the LTAs remain bounded by the current analysis of record.

2.0 DETAILED DESCRIPTION

The LTR design described in the March 8, 2018 EGC submittal states that the uranium silicide (U_3Si_2) pellets in each rod will be enclosed in a capsule within a sealed segmented rod of approximately one foot in length, and that the segmented rod is inserted into a standard fueled rod to make up part of the normal-length fuel rod. The modified LTR design eliminates the capsule so that the uranium silicide pellets will be loaded directly into the approximately one foot long sealed Optimized ZIRLO™ clad rod segment. The fueled segment will utilize a thicker clad compared to the other rods in the assembly. The modified design also includes solid Zircaloy

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[1] *EnCore, ADOPT, and Optimized ZIRLO are trademark or registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.*

bars in the remainder of the normal full-length rod, rather than fuel. As a result of this design, the conservative thermal margin cutback is based on the peak power of this one-foot axial segment, rather than integral rod power.

The modified LTR design change affects only the four (4) uranium silicide LTRs (EnCore®) and two of the ADOPT™ LTRs. There is no change to the ADOPT™ fuel pellets or the coated Optimized ZIRLO™ cladding. The LTA make-up is revised to reflect the uranium silicide LTR modification as well as to eliminate the use of the ADOPT™ uranium dioxide fuel pellets with the standard Optimized ZIRLO™ clad and only use the ADOPT™ pellets with the coated Optimized ZIRLO™ clad. The revised composition of the two LTAs, which will continue to contain up to a combined total of 20 LTRs, is as follows:

LTA #1 is a Westinghouse VANTAGE+ Optimized Fuel Assembly design containing:

- Up to four rods with uranium silicide (U_3Si_2) pellets and Optimized ZIRLO™ cladding. The U_3Si_2 pellets will be enclosed in a sealed clad segment with the segment positioned between two solid Zircaloy bars.

- Up to four rods with standard uranium dioxide (UO_2) pellets and coated Optimized ZIRLO™ cladding

- All other rods in LTA #1 will have standard uranium dioxide pellets and standard Optimized ZIRLO™ cladding

LTA #2 is a Westinghouse VANTAGE+ Optimized Fuel Assembly design and contains:

- Up to eight rods with standard uranium dioxide pellets and coated Optimized ZIRLO™ cladding

- Up to four rods with Westinghouse ADOPT™ uranium dioxide pellets and coated Optimized ZIRLO™ cladding

- All other rods in LTA #2 will have standard uranium dioxide pellets and standard Optimized ZIRLO™ cladding

There are no other differences compared to the existing resident VANTAGE+ fuel assembly design.

3.0 TECHNICAL EVALUATION

3.1 Nuclear Safety and Design Impacts

The behavior of the core continues to be dominated by the currently approved fuel. The core, including the LTAs, will be designed to ensure that the Technical Specification 4.2.1 "Fuel Assemblies" requirement to place the LTAs in non-limiting core regions continues to be met. The core design criteria used to ensure this requirement is met are as follows:

a. The LTRs will be designed to be at a lower power than the lead rod power (i.e., 5% for uranium silicide LTRs, 2% for Coated Clad and ADOPT™ LTRs).

b. The LTRs containing the uranium silicide within the LTA will be designed with a smaller pellet diameter relative to the UO_2 rods. They are not expected to be neutronically similar to the symmetric uranium dioxide rods as the new design is only a segment which cannot be compared to a full rod.

c. The safety parameters related to peaking factors/thermal limits will be analyzed with the uranium silicide, ADOPT™ pellets, and chromium coating explicitly modeled in the neutronic calculations.

d. The LTAs will not be placed in rodded locations considered in the Rod Ejection Accident analyses.

The reduced diameter of the uranium silicide pellets obviates the need for reducing the enrichment of these pellets, as was previously described in Reference 6.1.

The design basis limits/criteria described in Reference 6.1 are unchanged by the LTR changes described in this document but the above core design restrictions supersede the initial restrictions described in Sections 3.3 and 4.1 of Reference 6.1.

3.2 Technical Analysis Impacts

The LTR design change described in Section 2 of this document affects the four (4) uranium silicide LTRs and two of the ADOPT™ LTRs. There is no change to the design of the ADOPT™ fuel pellets or the coated Optimized ZIRLO™ cladding, only an increase in the number of ADOPT™ rods using the coated Optimized ZIRLO™ from two to four rods. Since there is limited impact on the make-up of the two LTAs, it is expected that there will be no impact to the LOCA; non-LOCA; thermal-hydraulic; fuel handling, storage, and shipping; BEACON core monitoring system; or alternative source term methodologies described in Reference 6.1. Impacts to the other technical evaluations are described below.

Mechanical Design Methodology

To ensure a conservative deployment of the new uranium silicide fuel type, a segmentation strategy will be employed for these four LTRs. The uranium silicide pellets will be loaded directly into a sealed Optimized ZIRLO™ rod segment of approximately one foot in length with a thicker clad.

The uranium silicide fueled segment will be placed between fuel assembly spacer grids, thus eliminating the risk of grid-to-rod failure and debris fretting failure. The thicker clad will also increase corrosion margin and pellet-clad mechanical interaction margin. The segment will utilize Optimized ZIRLO™ cladding in all four LTRs.

The uranium silicide LTRs will be lighter than the standard fuel rods because they have less fuel; however, no vibration-related impact on reactor performance is anticipated.

Seismic

The impact of the uranium silicide rod design change will be negligible. The change in LTA weight associated with the LTR modification is not expected to have any detrimental impact on fuel assembly seismic characteristics. Westinghouse will evaluate the grid deformation analysis to ensure adequate margin is maintained and that the ability to maintain a coolable geometry is not impacted.

Core Physics

For conservatism, the primary design criterion is to maintain the uranium silicide LTR power peaking at least 5% below the core power peaking. The associated LTA will also be one of the lower enrichment reload batch assemblies. The associated design criteria for the ADOPT™-fueled and the coated Optimized ZIRLO™ LTRs will be to maintain the power peaking at least 2% below the core maximum power peaking. Note that the 5% and 2% power suppression will be design criteria utilized when creating the core loading pattern and will not be monitored during plant operation. The LTRs will not be designed to lead the core in power peaking at any time during planned operation. Westinghouse fuel design and core design methods can accommodate the unfueled Zircaloy bars on the top and bottom of the uranium silicide segment, and there will be no significant increase in uncertainty or risk introduced by the unfueled inert regions.

Fuel Rod Design

No adverse effects are anticipated from the modified uranium silicide LTR design. The uranium silicide rods will not have uranium on their extremities which negates comparison to a full-length symmetric partner's rod average burnup. A comparison is feasible of the unique uranium silicide segment design to 1 foot segments of UO_2 fueled rods in similar locations in the core. The standard UO_2 rods in the LTA will meet all applicable limits, including those related to burnup, throughout all cycles of operation. The overall core design will continue to meet all applicable design criteria using approved methodologies, standard loading pattern strategies, and monitoring of rod burnup at the core design level. The LTRs with uranium silicide, including the thicker cladding and unfueled remainder of the segmented rod, are being analyzed with the developmental PAD-ATF fuel performance code. Preliminary results indicate that the segment has increased margin to most key fuel rod performance criteria due to operating at a lower fuel temperature due to its higher thermal conductivity.

4.0 REGULATORY EVALUATION

EGC has reviewed the information supporting the No Significant Hazards Consideration that was previously provided to the NRC in Reference 6.1. The modification of the LTRs described in this supplement does not affect the conclusion that the proposed license amendment does not involve a significant hazards consideration.

5.0 ENVIRONMENTAL CONSIDERATION

EGC has reviewed the information supporting the Environmental Consideration that was previously provided to the NRC in Reference 6.1. This modification of the LTRs described in

this supplement does not affect the conclusion that neither an environmental impact statement nor an environmental assessment need to be prepared in support of the proposed amendment.

6.0 REFERENCES

6.1 Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "License Amendment Request to Utilize Accident Tolerant Fuel Lead Test Assemblies," dated March 8, 2018, ADAMS Accession No. ML18067A431

6.2 Byron/Braidwood Stations, Updated final Safety Analysis Report, Section 4.2, "Fuel System Design"

6.3 Byron Station Technical Specification 4.2.1, "Fuel Assemblies"