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NEI 03-08

September 28, 2026

LTR: Byron 2026-0065
SRRS: 1D.101

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. STN 50-455

Subject: Notification of Deviation from Pressurized Water Reactor Owners Group (PWROG), WCAP-17451-P Revision 2, "Reactor Internals Guide Tube Wear – Westinghouse Domestic Fleet Operational Projections"

Constellation Energy Generation, LLC (CEG) is providing notification that Byron Station, Unit 2, has processed a deviation from a Nuclear Energy Institute (NEI) 03-08, "Guideline for the Management of Materials Issues," Revision 4, "Needed" work product element in PWROG Report, WCAP 17451-P, Revision 2, "Reactor Internals Guide Tube Wear – Westinghouse Domestic Fleet Operational Projections" with appropriate justification and documentation.

Control Rod Guide Tube (CRGT) Guide Card Wear Measurement (GCWM) is a "Needed" requirement specified in WCAP-17451-P, Revision 2, Section 6.0. Byron Unit 2 has elected to delay baseline wear measurements of its CRGT guide cards from Refuel Outage B2R26 (Fall 2026, 35.8 EFPY) to no later than Refuel Outage B2R30 (Fall 2033, 42.8 EFPY).

NEI 03-08 allows deviation from "Needed" elements with the appropriate justification and documentation. The deviation was approved with the appropriate levels of CEG management.

Attachment 1 provides the Technical Evaluation for NEI 03-08 Deviation of Control Rod Guide Tube Guide Card Wear Measurement for Byron Unit 2 (EC 646788 - Rev.1) and attachment 2 provides the deviation form with approval CEG signatures.

This notification is provided for information only. No approval or action is expected.

There are no regulatory commitments contained in this letter.

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If you have any questions concerning this letter, please contact Zoe Cox, Regulatory Assurance Manager, at (815) 406-2800.

Respectfully,



Harris Welt
Site Vice President
Byron Nuclear Generating Station

HW/ZLC/rf

Attachment 1: Technical Evaluation for NEI 03-08 Deviation of Control Rod Guide Tube Guide
Card Wear Measurement for Byron Unit 2 (EC 646788 - Rev.1)

Attachment 2: ER-AA-4003 Attachment 2 – NEI 03-08 Deviation Form for Control Rod Guide
Tube Guide Card Wear Measurements for Byron Unit 2

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

**Technical Evaluation for NEI 03-08 Deviation of Control Rod Guide Tube Guide Card
Wear Measurement for Byron Unit 2**

1. Reason for Evaluation / Scope

Byron Unit 2 has elected to defer the baseline Control Rod Guide Tube (CRGT) Guide Card Wear Measurements (GCWM), from B2R26 (Fall 2026, 35.8 EFPY) to no later than B2R30 (Fall 2033, 42.8 EFPY). The GCWM are classified as Nuclear Energy Institute (NEI) 03-08 [2] “needed” Guidance, specified in Section 6 of WCAP-17451-P Revision 2 [4]. A deviation is required since the proposed exam schedule is beyond the recommended baseline inspection timing listed WCAP-17451-P Rev. 2 [4].

The timeline for baseline inspections is documented in Table 5-14 and Section 5.4 of WCAP-17451-P Rev. 2. Byron Unit 2 is denoted as “Plant R” in Table 5-14 and specifies baseline inspection should take place prior to 32.0 Effective Full Power Years (EFPY). Section 5.4 allows an additional 4 years for baseline inspections, equating to 36.0 EFPY. The inspection range for Byron Unit 2 was developed through review of guide card ligament wear reviewed in Foreign Material Exclusion (FME) videos that were recorded during the B2R13 (Spring 2007, 17.2 EFPY) refueling outage (RFO) as part of the CRGT Split Pins Replacement Projects [8].

Westinghouse and the Pressurized Water Reactor Owners Group (PWROG) identified guide card wear as a significant emerging issue in the nuclear industry. The Electric Power Research Institute (EPRI) adopts WCAP-17451-P Rev. 2 baseline inspections timing and coverage requirements by reference in MRP-227 Revision 2-A [1] document and establishes these requirements as NEI 03-08 [2] “needed” guidance. When a utility determines that “Needed” work product elements will not be fully implemented or will not be implemented in a manner consistent with their intent, or when a work product will not be implemented within the timeframe specified, a technical justification shall be developed to deviate from a “Needed” requirement. This deviation serves as the technical justification to defer from baseline measurement which reduces the radiation dose incurred during the inspection activities performed in B2R26 without any reduction in quality or safety.

2. Detailed Evaluation

Byron Unit 2 is a Westinghouse 4-loop with an upper internals assembly containing CRGTs. The unit has 55 total CRGTs, with 53 active locations using a 17x17 150” standard design made of Type 304 Stainless Steel. Each CRGT contains 8 guide cards plus a continuous section located at the bottom of the CRGT. The guide cards are approximately one-inch thick, spaced about one foot apart, and are used to guide the Rod Cluster Control Assemblies (RCCAs) to step in and out of the fuel assemblies. Specifically, the RCCA are made up of long, slender rodlets and the guide cards are designed to allow axial movement of the rodlets. The primary concern of excess guide card wear is loss of guidance of the individual rodlets may occur and the unsupported length of the rodlet will increase. Given the nature of the long and slender rodlets, consecutive worn guide cards pose a safety

concern that the rodlets could buckle and increase control rod drop time or jam during core shutdown, impeding RCCA insertion into the core.

To support the deferral of “Needed” Guidance, Westinghouse provided Letter CBE-RV010-TM-CG-000001, Rev. 0-A [5] that reevaluates the timing for baseline inspection specified in Table 5-14 and Section 5.4 of WCAP-17451-P Rev. 2. The letter reassesses three inputs:

1. Guide card slot width comparison between the operational time extension curves of WCAP-17451-P Rev. 2 [4] vs. the most limiting curves of WCAP-17451-P Rev. 1 [3]
2. Guide card ligament and chamfer comparison between FME videos wear measurements (B2R13, Spring 2007, 17.2 EFPY) [8] with measurement uncertainties and wear projections of WCAP 17451-P Rev. 1 [3] and Rev. 2 [4]
3. Comparison between wear projections of WCAP 17451-P Rev. 1 [3] and Rev. 2 [4], and Byron Unit 1 GCWM results (B1R25, Spring 2023, EFPY 32.95) [7].

WCAP-17451-P Rev. 1 and 2 specify that baseline inspections should be conducted during the Green Zone, during a period of no wear and 5 EFPY before the start of the Red Zone. The most conservative criterion of the start of the Red Zone is defined as two EFPY before one guide card has a worn-through slot opening equal to 85% of the adjusted rodlet diameter, see Table 5-8 in WCAP-17451-P Rev. 2 [4]. The projected end of the Red Zone for Byron Unit 2, as defined by the most conservative definition, is 38.8 EFPY. However, Westinghouse analysis CN-RIDA-17-95 (Ref. 23 in WCAP-17451-P Rev. 2) demonstrated that control rod insertion will still occur with the Byron Unit 2 CRGT design with up to 6 consecutive worn-through guide cards. Therefore, the end of the Red Zone and the point at which rod use of the CRGT should be discontinued if not repaired or reevaluated, is when seven (7) consecutive guide cards reach the Red Zone, see table 5-7 of WCAP-17451-P Rev. 2 [4].

Time extension curves of WCAP-17451-P Rev. 1 [3] assume a limiting flow case, are conservative, and predict the worst worn CRGT to reach the end of the Red Zone in 38.8 EFPY. However, these time extension curves were demonstrated to be excessively conservative for certain CRGT designs and operating conditions, including at Byron Unit 2 which uses chrome-plated RCCA rodlets in its 17”x17” Standard 150” CRGT design. Therefore, WCAP-17451-P Rev. 2 introduced new operational time extension curves which more accurately reflected the CRGT guide card wear seen in the industry. By reevaluating using the combined operational time extension curves from WCAP-17451-P Rev. 2, the inspection timing requirements for Byron Unit 2 are extended. Westinghouse Letter CBE-RV010-TM-CG-000001, Rev. 0-A [5] updates the timeline using the combined operational time extension curves for the three worst worn CRGTs visually identified from the FME videos: N11, N07, and K06. The updated timeline for the worst worn guide card slot width to reach the start of the Red Zone for CRGT N11, N07, and K06 are projected to be 50.9 EFPY, 54.8 EFPY, and 54.4 EFPY, respectively. It is important to note that only the worst worn guide cards for each CRGT are evaluated using this method and the remaining guide cards in each CRGT will only add margin since Table 5-7 of WCAP-17451-P Rev. 2 allows up to 6 consecutive guide cards to be worn-through, as Westinghouse analysis CN-RIDA-17-95

(Ref. 23 in WCAP-17451-P Rev. 2) demonstrated that control rod insertion will still occur with the Byron Unit 2 CRGT design with up to 6 consecutive worn-through guide cards.

The second input reconsidered in Westinghouse Letter CBE-RV010-TM-CG-000001, Rev. 0-A [5] was the ligament and chamfer wear measurements on each guide card and the top of the continuous section of the three worst CRGT. These wear measurements were also taken from the FME videos, while attempting to capture the same cardinal hole location in each guide card. The measurements were used to predict wear using GCWM tool and software with the WCAP-17451-P Rev. 2 methodologies. For the CRGTs N11, N07, and K06, the timeline to reach the start of the Red Zone based on these measurements is 73.6 EFPY, 68.2 EFPY, 67.3 EFPY, respectively. The measurements taken from the FME videos have a higher uncertainty than the wear measurements taken with the GCWM tool and software, and so additional uncertainty runs were performed to show the potential impact of the measurement bias/uncertainty. Considering a 0.01-inch bias in all measurements, the timeline to reach the start of the Red Zone for CRGT N11, N07, and K06 is projected to be 51.0 EFPY, 48.9 EFPY, and 48.4 EFPY, respectively.

The third input described in Westinghouse Letter CBE-RV010-TM-CG-000001, Rev. 0-A [5] was the comparison between wear projections for both units at Byron and GCWM data collected during B1R25 for Byron Unit 1 and is summarized in Table 1 below. All EFPY reported in Table 1 shows cumulative EFPY until the start of the Red Zone, or years since the start of plant operation. It is important to note that the GCWM data from B1R25 provides a more accurate wear summary than measurement results from reviewing FME videos from B1R13. Although the GCWM data showed CRGT F08 and K02 were the worst worn compared with the FME video results that showed H08 and N11 as the worst worn, the worst CRGT at Byron Unit 1 is not projected to reach the Red Zone until 80.8 EFPY, which is substantially far beyond when the deferred CRGT examinations are proposed for Byron Unit 2. Byron Units 1 and 2 have the same CRGT design, both use chrome-plated RCCA rodlets, and have operated similarly over the course of their plant lifespans. Therefore, the Byron Unit 1 GCWM serve as a useful comparison to the Byron Unit 2 CRGTs.

Industry OE that performed guide card wear measurements under WCAP 17451-P Rev. 1 were excluded from comparison in Table 2 of this document as it uses a much more conservative methodology for calculating the EFPY estimated for the CRGT wear to reach the red zone criteria. This includes sites such as North Anna unit 1 and Farley Units 1 and 2. Guide card wear measurements from sites with ion nitride rodlets and those made with different material were also excluded. Per WCAP-17451-P sites that use ion nitride rodlets could be more susceptible to guide card wear. This includes sites such as Salem units 1 and 2, and Diablo Canyon unit 1. This EC compares sites that use chrome plated rodlets similar to Byron Unit 2 and utilized Revision 2 of WCAP-17451-P, such as D.C. Cook unit 2, Beaver Valley Unit 1 and VC Summer. Looking at the data documented in Table 2, the earliest it is estimated that a location would meet the red criteria is VC Summer at 69.1 EFPY, and the next soonest being Beaver Valley Unit 1 at 103.18 EFPY [12, 13]. This data paired with the data collected at Byron Unit 1 supports the expectation that the Byron Unit 2 guide cards are safe for continued operation. Westinghouse Letter CBE-RV010-TM-CG-

000001 supports a deviation on guide card baseline inspections on Byron Unit 2 until Fall 2033 with 42.8 EFPY.

Table 1. Constellation's CRGT Wear Projections Comparisons

Plant	EFPY at Meas.	Limiting CRGT	FME Results ⁽⁵⁾	FME Results with 0.01-inch bias ⁽⁵⁾	GCWM Results ⁽⁵⁾	Operational Time Extension Curves ⁽⁵⁾⁽⁶⁾
Chrome Plated Control Rodlet Surface Finish						
Byron Unit 2 ⁽¹⁾	17.2	N11 ⁽³⁾	73.6	51.0	-	52.9
		N07 ⁽³⁾	68.2	48.9	-	56.8
		K06 ⁽³⁾	67.3	48.4	-	56.4
Byron Unit 1 ⁽¹⁾	15.9	H08 ⁽³⁾	66.8	46.8	66.8	40.4
		N11 ⁽³⁾	82.0	53.8	82	33.1
Byron Unit 1 ⁽²⁾	32.95	H08 ⁽⁴⁾	-	-	102.8	-
		N11 ⁽⁴⁾	-	-	102.9	-
		F08 ⁽⁴⁾	-	-	88.7	-
		K02 ⁽³⁾	-	-	80.9	-
Notes: 1. Data based on FME video review from B1R13/B2R13 [BYR] 2. Data from GCWM results from B1R25[7] 3. Limiting EFPY due to guide card wear 4. Limiting EFPY due to continuous section wear 5. Using WCAP-17451-P Rev. 2 methodology 6. Guide card slot width reaching unworn rodlet diameter						

Table 2. Industry's CRGT Wear Projections Comparison

Plant	EFPY at Meas.	Limiting CRGT	GCWM Results [EFPY at measurement + EFPY to red zone]
Chrome Plated			
D.C. Cook Unit 2⁽³⁾	26.739	M08	109.3
		D08	157.5
Beaver Valley Unit 1⁽¹⁾	36.28	F10	103.1
VC Summer⁽²⁾	32.3	G03	69.1
Notes: 1. MRP 2024-019 Inspection Summary Report [13] 2. MRP 2022-017 Inspection Summary Report [12] 3. Westinghouse Letter LTR-RIDA-20-4, Revision 0			

3. Conclusion

The proposed Byron Unit 2 CRGT GCWM deferral from B2R26 (Fall 2026, 35.8 EFPY) to no later than B2R30 (Fall 2033, 42.8 EFPY), remains supported with sufficient margin demonstrated in Westinghouse Letter CBE-RV010-TM-CG-000001, Rev. 0-A [5] and the comparison of Byron Unit 2 wear projections to Byron Unit 1 GCWM from B1R25 [7]. The letter assessed three inputs for the most limiting CRGTs, and the most conservative estimate for the start of the Red Zone is 48.4 cumulative EFPY. The proposed examination timeline will satisfy the WCAP-17451-P Rev. 2 Green Zone Guidance for every projection in Table 1, more than 5 EFPY from the start of the Red Zone. Based on the proven, conservative CRGT projection methodologies in WCAP-17451-P, Rev. 2, the data from the Byron Unit 2 CRGTs, and the operating experience with the 17"x17" Standard 150" CRGT design, this deferral of four refueling outages to no later than 42.8 EFPY is acceptable and poses no additional measurable risk in failure of a control rod to insert due to CRGT guide card wear.

4. References

- [1] Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines (MRP-227, Revision 2-A). EPRI, Palo Alto, CA: 2025. 3002031794.
- [2] NEI 03-08, Revision 4, "Guideline for the Management of Materials Issues," Nuclear Energy Institute, October 2020.
- [3] PWROG Report, WCAP-17451-P, Revision 1, "Reactor Internals Guide Tube Wear – Westinghouse Domestic Fleet Operational Projections," October 2013.
- [4] PWROG Report, WCAP-17451-P, Revision 2, "Reactor Internals Guide Tube Wear – Westinghouse Domestic Fleet Operational Projections," November 2018.
- [5] Westinghouse Letter CBE-RV010-TM-CG-000001, Rev. 0-A, "Guide Card Wear Baseline Inspection Deferral Inputs for Byron Unit 2", April 2025.
- [6] EC 640658, Revision 0, Technical Evaluation for NEI 03-08 Deviation of Control Rod Guide Tube Guide Card Wear Measurements for Braidwood Units 1 and 2.
- [7] Westinghouse Report, WCAP-18847, Revision 0, "Byron Unit 1 – Upper Internals 17x17 Guide Tube – Guide Card Wear Evaluation," May 8, 2023.
- [8] EC 349592, Revision 1, Replace Control Rod Drive Tube Support Pins with Material Resistant to Primary Water Stress Corrosion Cracking, Byron Unit 2.
- [9] ER-AA-4003, Revision 6, Materials Degradation Management Program (MDMP) Deviation Guidance.
- [10] CC-AA-309-101, Revision 16, Engineering Technical Evaluations.
- [11] HU-AA-1212, Revision 13, Technical Task Risk/Rigor Assessment, Pre-Job Brief, Independent Third Party Review, and Post-Job Brief.
- [12] MRP 2022-017, Tables for Reporting MRP-227-A Inspection Results for Westinghouse Plants.
- [13] MRP 2024-019, Tables for Reporting MRP-227-A Inspection Results for Westinghouse Plants.
- [14] Westinghouse Letter LTR-RIDA-20-4, Revision 0, "Guide Card Wear Baseline Inspection Deferral Inputs for Byron Unit 1," February 4, 2020.

5. Technical Review

The detailed evaluation was verified correct, and the associated conclusions are deemed reasonable through independent review of the Technical Evaluation. The requirements of the HU-AA-1212 were reviewed and no independent third-party review was required. A human performance briefing per HU-AA-1212 was completed on 01/13/2026 by Jacky Shoulders in association with this document.

Since there are no configuration changes or plant modifications performed by this technical evaluation, it has been determined that a Design Attribute Review (DAR) is not warranted. The Programs Engineering Manager has concurred with this decision.

Revision 0 of EC 646788 was approved previously. New revision provides additional data from industry OE, removes business case as one of the reasons for deviation, and incorporates feedback from PWROG utility peers.

Preparer: Yash Mamtora/Mario Medina **Signature:** EC electronically signed on AS9

Independent Reviewer: Kemper Young **Signature:** EC electronically signed on AS9

Approver: Romit Patel **Signature:** EC electronically signed on AS9

ATTACHMENT 2
MDMP Deviation Form
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Utility: Constellation Energy Generation (CEG), LLC

Applicable Site(s) and Unit No.: Byron Unit 2

Utility Contact(s):

Yash Mamtora – Fleet PWR Internals Programs Engineer, Yash.Mamtora@constellation.com
Dionora Osmani – Fleet PWR Internals Program Engineer, Dionora.Osmani@constellation.com
Austin Bowley – Byron Site PWR Internals Programs Engineer, Austin.Bowley@constellation.com

Issue Program (IP) activity or document:

PWROG Report, WCAP-17451-P, Revision 2, “Reactor Internals Guide Tube Wear – Westinghouse Domestic Fleet Operational Projections,” November 2018.

Scope / Description of Deviation:

CEG is submitting a revision of a NEI 03-08 deviation for Byron Unit 2 to perform the baseline Control Rod Guide Tube (CRGT) Guide Card Wear Measurements (GCWM) no later than the B2R30 (Fall 2032) RFO.

The Nuclear Energy Institute (NEI) 03-08 “Needed” requirements are identified in WCAP-17451-P Revision 2, Section 6.0. As such, WCAP-17451-P, Revision 2, Table 5-14 and Section 5.4 specify that the baseline CRGT GCWM for Byron Unit 2 should take place prior to 32.0 and 36.0 Effective Full Power Years (EFPY), respectively. Per NEI 03-08, “Needed” requirements or guidance are “*to be implemented whenever possible but alternative approaches are acceptable.*” Technical justification has been developed under EC 646788 to deviate from the “Needed” requirement in WCAP-17451-P Revision 2, Section 6.0 because it will not be implemented within the timeframe specified therein.

The purpose of Revision 1 is to incorporate industry/peer utility feedback in the deviation and correct any typos. The outcome of the new revision remains the same as the outcome in Revision 0.

Reason for Deviation:

To defer the baseline CRGT GCWM for four additional RFOs to provide the station with a more favorable business case and outage planning and execution with no reduction in quality and safety.

IR Number: 04926195

EC Number: 646788, Revision 1

Time Frame the Deviation will be in Effect: B2R30, Fall 2032, 42.8 EFPY

Deviation to this IP document is classified as: NEEDED

ATTACHMENT 2
MDMP Deviation Form
Page 2 of 2

Preparer and Corporate IP Primary Representative: Mario Medina Medina, Mario Digitally signed by Medina, Mario
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Peer Reviewer: Kemper Young Young, Kemper Joseph Digitally signed by Young, Kemper Joseph
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Byron Programs Manager: Romit Patel Patel, Romit Digitally signed by Patel, Romit
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