EC 639996 (Byron), Revision 1 and 640160 (Braidwood), Revision 0
Technical Evaluation for NEI 03-08 Deviation of Baffle-Former Bolts Volumetric Examinations for Byron and Braidwood

1. Reason for Evaluation/Scope

Byron Units 1 and 2 and Braidwood Unit 2 are scheduled to perform the Reactor Vessel Internals (RVI) examinations in accordance with MRP-227, Revision 1-A [1] during the Spring 2026, Fall 2026, and Fall 2027 refueling outages, respectively. These examinations include the volumetric examinations of the Baffle-Former Bolts (BFBs), which are typically performed using the ultrasonic testing (UT) method. These plants are considered Tier 4 plants per NSAL-16-1, Revision 1 [2].

Table 4-3 (Item W6) of MRP-227, Revision 1-A [1] requires that Tier 4 plants perform baseline volumetric examinations of BFBs no later than 35 effective full power years (EFPY), as stated in Note 8 of Table 4-3 [1]. Based on the schedule of the RVI examinations for Byron Units 1 and 2 and Braidwood Unit 2, these plants will exceed the EFPY requirement for performing these baseline examinations. Per the implementation requirements under Subsection 7.3 of MRP-227, Revision 1-A [1], there is a NEI 03-08 [3] "Needed" requirement which states, *each commercial U.S. PWR unit shall implement the requirements of Tables 4-1 through 4-9 and Tables 5-1 through 5-3 for the applicable design* [1]. Per NEI 03-08 [3], "Needed" requirements or guidance are *to be implemented whenever possible but alternative approaches are acceptable*. Technical justification shall be developed to deviate from the "Needed" requirement above because it *will not be implemented within the timeframe specified* in MRP-227, Revision 1-A [1]. As such, a deviation is required to extend the current requirement of 35 EFPY to 36 EFPY to bundle the baseline volumetric examinations of BFBs with the rest of the RVI examinations to reduce person-rem exposure and outage complexity. This evaluation serves as the technical justification for that deviation.

2. Detailed Evaluation

Byron and Braidwood are Westinghouse 4-loop plants with neutron panels continuously operated with the baffle-former assembly in the upflow configuration. As such, they are considered Tier 4 plants per NSAL-16-1, Revision 1 [2]. Each unit has a total of 832 BFBs made of Type 316 stainless steel material. The BFBs are located on the baffle plates and fasten the baffle plates to the former plates. The baffle plates are the vertical components that are next to the fuel when the core is in place. The baffle plates are supported by horizontal supports called former plates. These components compose the baffle-former assembly. The function of the baffle-former assembly is to maintain the fuel assembly structural integrity to ensure that the control rods insert, maintain a coolable core geometry, and ensure a core configuration that supports long-term reactor shutdown.

As shown in Table 4-3, MRP-227, Revision 1-A [1] requires a volumetric examination of 100% of the BFBs. The initial examination for Tier 4 plants is required by 35 EFPY, and subsequent examinations are required on a 10-year interval unless significant degradation ($\geq$ 5% of BFBs with indications or clustering as defined in NSAL-16-1 Revision 1 [2]) is observed. With the current RVI examination schedule in place for Byron Units 1 and 2 and Braidwood Unit 2, these three units are projected to exceed 35 EFPY prior to performing the required baseline volumetric examinations of their BFBs. Table 1 shows the RVI examination schedule for these units and the projected cumulative EFPY at which these examinations are scheduled to be performed. EFPY projections were made by adding 1.5 EFPY per 18-month fuel cycle from the accumulated EFPY values from the last refueling outage.

Table 1 – RVI Examinations Schedule and EFPY Projections

Plant	Last Outage Date	Last Outage EFPY	Examination Outage Date	Projected EFPY at Examination
Byron Unit 1	Spring 2023	32.951	Spring 2026	35.951
Byron Unit 2	Fall 2023	32.814	Fall 2026	35.814
Braidwood Unit 2	Spring 2023	31.275	Fall 2027	35.775

The volumetric examinations of BFBs are intended to detect the potential cracking failure of the bolts due to irradiation-assisted stress corrosion cracking (IASCC) or fatigue. Most of the BFB degradation observed in the industry, and the worst of the degradation, has been found in plants that operate in the downflow configuration. The elevated degradation in those plants has been linked to the higher stresses on the BFBs due to the pressure differential caused by the downflow configuration. Plants with upflow configuration, like Byron Units 1 and 2 and Braidwood Unit 1, have lower differential pressure which causes lower stresses on the BFBs.

The most recent UT inspection results from the original and converted upflow plants that have performed their RVI examinations show very minimal BFB degradation (less than 1% of BFBs with indications and no clustering). These results as shown in Table 2.

Table 2 – Industry Results of Volumetric Examinations of BFBs for Tier 3 and 4 Plants

Plant	Reactor Design	Config.	Year	EFPY	Total Insp.	SAT	RI	UI
Wolf Creek	4-loop Neutron Panel	Upflow	2021	30.15	832	831	0	1
VC Summer	3-loop Neutron Panel	Converted Upflow (~2008)	2021	32.3	1088	1080	7	1
Callaway	4-loop Neutron Panel	Upflow	2022	31.76	832	832	0	0
Point Beach 1	2-loop Thermal Shield	Converted Upflow	2022	42.2	728	728	0	0
Point Beach 2	2-loop Thermal Shield	Converted Upflow	2023	42.89	202 (out of 728)	202	0	The rest of 526 BFBs not inspected due to vendor equipment issues
North Anna 1	3-loop Thermal Shield	Converted Upflow (1996)	2016	31.05	1088	1078	3	7
Beaver Valley 1	3-loop Thermal Shield	Converted Upflow	2022	~35	1088	1076	0	12
Almaraz 2	3-loop Neutron Panel	Upflow	2022	34.5	960	957	2	1

Note: **SAT** – Satisfactory, **RI** – Relevant Indication, **UI** – Un-inspectable

Based on Table 2, none of the mentioned plants have ever come close to having BFB degradation that would threaten structural integrity of the baffle-former assembly. Furthermore, Wolf Creek and Callaway,

the two plants with the most similar designs to Byron and Braidwood, have the best BFB UT inspection results and did not find a single BFB with a RI. As such, the probability of significant BFB degradation (≥ 5% of BFBs with indications or clustering as defined in NSAL-16-1 Revision 1 [2]) at Byron Units 1 and 2 and Braidwood Unit 2 is very low based on industry operating experience and low relative stresses on the BFBs. Plus, Byron and Braidwood had never experienced fuel failures due to baffle-jetting, which is a well-known symptom of BFB degradation at Westinghouse-designed PWRs. Therefore, performing the baseline volumetric examinations of the BFBs no later than 36 EFPY is prudent and will not be a safety concern.

The intent of the MRP-227, Revision 1-A guidance is to proactively inspect RVI components prior to them undergoing significant degradation, thereby adequately managing the aging of the components. With the RVI examination schedule for Byron Units 1 and 2 and Braidwood Unit 2 outlined in Table 1, these units will still meet this intent, as demonstrated by the technical justification in this evaluation.

3. Conclusions / Findings

Based on Byron's and Braidwood's history of no fuel failures due to baffle-jetting, good industry operating experience of BFB degradation for Tier 3 and 4 plants, and low relative stresses on their BFBs due to their upflow configuration, it is acceptable to perform the baseline volumetric examinations of the BFBs beyond 35 EFPY, but no later than 36 EFPY. Therefore, performing the baseline volumetric examinations of the BFBs no later than 36 EFPY will reduce person-rem exposure and outage complexity by bundling these with the rest of the RVI examinations while still providing an acceptable level of quality and safety.

4. References

[1] MRP-227, Revision 1-A, Materials Reliability Program PWR Reactor Internals Inspection and Evaluation Guideline.
[2] NSAL-16-1, Revision 1, Baffle-Former Bolts.
[3] NEI 03-08, Revision 4, Guideline for the Management of Materials Issues.
[4] MRP 2014-009, 2014 Biennial Report of Recent MRP-227-A Reactor Internals Inspection Results.
[5] MRP 2016-008, 2016 Biennial Report of Recent MRP-227-A Reactor Internals Inspection Results.
[6] MRP 2018-025, 2018 Biennial Report of Recent MRP-227-A Reactor Internals Inspection Results.
[7] MRP 2020-015, 2020 Biennial Report of Recent MRP-227-A Reactor Internals Inspection Results.
[8] MRP 2022-017, 2022 Biennial Report of Recent MRP-227-A Reactor Internals Inspection Results.
[9] MRP-227 Rev 1-A Reporting Tables for Westinghouse Plants, Point Beach Unit 1 U2R39.
[10] MRP Fall 2022 TAC Meeting, Operating Experience Technical Session, dated 11/15/2022.
[11] BB-PBD-AMP-XI-M16A, Revision 3, Byron and Braidwood PWR Vessel Internals Bases Document.
[12] TODI BYR-23-006, Revision 0, Cycle Burnup Values for Byron Unit 1 Cycles 1 through 25.
[13] TODI BYR-23-029, Revision 0, Cycle Burnup Values for Byron Unit 2 Cycles 1 through 24.
[14] EC 639058, Revision 0, Braidwood Unit 2 Cumulative Burnup in Effective Full Power Years Through Cycle 23 (A2R23).
[15] F-2956 and L-2956, Revision 0, Byron and Braidwood Procurement Specification for PWR In-Vessel Inspections.
[16] ER-AP-333, Revision 4, Pressurized Water Reactor Internals Management Program.

[17] ER-AP-333-1001, Revision 4, Pressurized Water Reactor (PWR) Internals Program.
[18] ER-AA-40, Revision 4, Materials Degradation Management Program (MDMP).
[19] ER-AA-4001, Revision 6, Materials Degradation Management Program (MDMP) Implementation Guidance.
[20] ER-AA-4003, Revision 6, Materials Degradation Management Program (MDMP) Deviation Guidance.
[21] CC-AA-309-101, Revision 16, Engineering Technical Evaluations.
[22] HU-AA-1212, Revision 13, Technical Task Risk/Rigor Assessment, Pre-Job Brief, Independent Third Party Review, and Post-Job Brief.

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 10/13/2023 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.

Preparer: Osvaldo Cruz **Signature:** Electronically signed in PassPort

Independent Reviewer: Kemper Young **Signature:** Electronically signed in PassPort

Approver: Jacky Shoulders **Signature:** Electronically signed in PassPort

Attachment 1

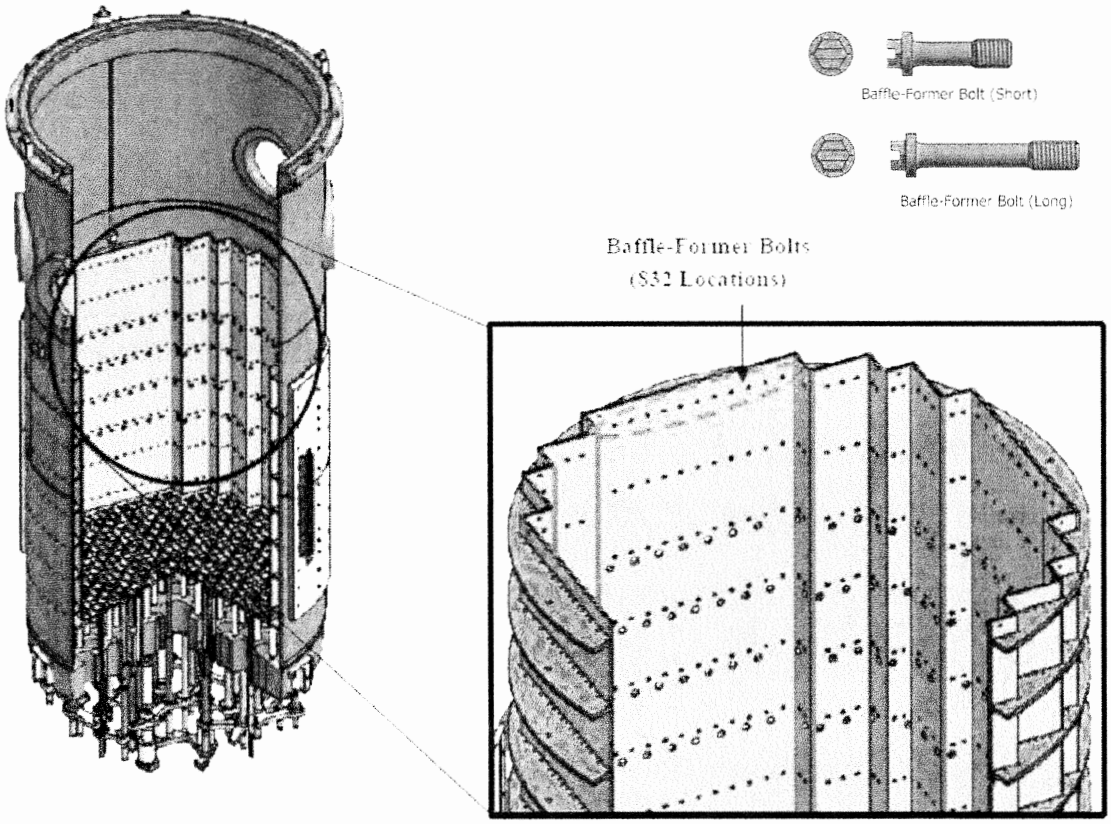

Figure 1 – Byron/Braidwood Units 1 and 2 Baffle-Former Bolts