

RS-22-050

April 8, 2022

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

Braidwood Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Renewed Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Supplemental Information - Proposed Alternative for Examination of
Pressurizer Circumferential and Longitudinal Shell-to-Head Welds
and Nozzle-to-Vessel Welds

- References:
- 1) Letter from D. Gudger (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "Proposed Alternative for Examination of Pressurizer Circumferential and Longitudinal Shell-to-Head Welds and Nozzle-to-Vessel Welds," dated May 12, 2021 (ML21133A297)
 - 2) Email from A. Mayer (U.S. Nuclear Regulatory Commission) to T. Loomis (Exelon Generation Company, LLC), "Calvert Cliffs Nuclear Power Plant, Units 1 and 2 - Request for Additional Information re: Proposed Alternative for Pressurizer Circumferential and Longitudinal Shell-to-Head Welds and Nozzle-to-Vessel Welds (EPID L-2021-LLR-0037)," dated October 13, 2021 (ML21287A032)
 - 3) Letter from D. Helker (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information - Proposed Alternative for Examination of Pressurizer Circumferential and Longitudinal Shell-to-Head Welds and Nozzle-to-Vessel Welds," dated November 16, 2021 (ML21320A242)
 - 4) Letter from D. Gudger (Constellation Energy Generation, LLC) to U.S. Nuclear Regulatory Commission, "Supplemental Information - Proposed Alternative for Examination of Pressurizer Circumferential and Longitudinal Shell-to-Head Welds and Nozzle-to-Vessel Welds," dated March 10, 2022 (ML22069A580)

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- 5) Email from J. Wiebe (U.S. Nuclear Regulatory Commission) to T. Loomis (Constellation Energy Generation, LLC), "Braidwood and Byron - Final RAI Regarding Proposed Alternative for Various Pressurizer Welds (EPID L-2021-LLR-0035 and 0036)," dated April 1, 2022

In the Reference 1 letter, Constellation Energy Generation, LLC (CEG) requested relief from the examination of pressurizer circumferential and longitudinal shell-to-head welds and nozzle-to-vessel welds for Braidwood Station, Units 1 and 2 and Byron Station, Units 1 and 2. In the Reference 5 email, the U.S. Nuclear Regulatory Commission requested additional information. The Reference 1 relief request is supported by the evaluations and conclusions presented in EPRI Report 3002015905 and is summarized as follows:

- A comprehensive industry survey involving 47 PWR units (US and international) was conducted by EPRI to determine the degradation history of these components. The survey reviewed examination results from the start of plant operation. Most of these plants have operated for over 30 years and in some cases over 40 years. Of the plants surveyed, 269 examinations have been performed on each of Item Numbers B2.11 and B2.12 and 590 examinations have been performed on Item Number B3.110. The survey results showed that no examinations identified any unknown degradation mechanisms (i.e., mechanisms other than those listed in Section 6.0 of the EPRI Report). No flaws have been identified for Item Numbers B2.12 or B3.110 and only 4 examinations for Item Number B2.11 identified flaws exceeding the acceptance criteria of Section XI. All these flaws have been analytically evaluated and there has been no change in the flaw size since the original evaluation. Based on this exhaustive industry survey, it is concluded that although the emergence of an unknown degradation mechanism cannot be completely ruled out, the possibility of the occurrence of such an unknown degradation mechanism is highly unlikely.
- The deterministic fracture mechanics (DFM) evaluation presented in Section 8.2 of the EPRI Report indicates that it would take a minimum of 433 years for a postulated initial flaw (with a depth equal to the ASME Code, Section XI acceptance standards) in the pressurizer welds to reach 80% through-wall (assumed as leakage). The maximum stress intensity factor (K) obtained from the analysis remained below the ASME Code, Section XI allowable fracture toughness. This demonstrates that the pressurizer components are very flaw tolerant.
- Demonstrating plant specific applicability of the EPRI report along with the probabilistic fracture mechanics (PFM) evaluations presented in Section 8.3 of the EPRI report, as supplemented by the Constellation Energy RAI responses (ADAMS Accession No. ML21320A242), indicate that the pressurizer welds at Byron and Braidwood can operate safely for over 80 years.
- The proposed inspection deferrals for Braidwood and Byron are an order of magnitude lower (32.1 years vs 433 years) than those justified by the results of the DFM and the PFM evaluations in the EPRI Report. These conservative inspection deferrals combined with the performance monitoring plan below, provide defense-in-depth for the analytically determined safe operating period.

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- Operating conditions at Byron and Braidwood have been satisfactory over the life of the Pressurizers and are bounded by the analysis in the EPRI Report. As shown in Table C-1 through C-4 of Reference 1, the number of actual transient cycles experienced by Byron and Braidwood is significantly less than what was evaluated in the EPRI report. In almost all cases the number of actual transient cycles experienced is less than or equal to half of what was used in the EPRI report and in most cases the number is significantly less than half. The same is true of the projected number of transient cycles expected over a 60-year operating life. This adds an additional layer of confidence in the extension of the pressurizer weld inspections.

In addition to the results of the DFM and PFM evaluations of the EPRI Report, which demonstrate that the pressurizer welds are very flaw tolerant, CEG has developed an additional performance monitoring plan. The performance monitoring plan will validate the continued adequacy of the PFM model and verify that no unexpected degradation mechanisms have developed over time.

As shown in Table 1 of Reference 1, Byron Station, Unit 2 requests the greatest length of deferral from the last ASME Section XI Inspection. Category B-B requested a maximum deferral of 32.1 years and Category B-D requested a maximum deferral of 27.6 years. As a performance monitoring plan, CEG will examine the following components at Byron Station, Unit 2 to the maximum extent possible:

- One (1) Category B-B, Item B2.11 top head shell-to-head circumferential weld
- One (1) Category B-B, Item B2.12 top head shell-to-head longitudinal weld
- Five (5) Category B-D, Item B3.110 nozzle-to-vessel welds consisting of:
 - One (1) spray nozzle
 - One (1) relief nozzle
 - Three (3) safety nozzles

The components to be examined as part of this performance monitoring plan are provided in the table below for reference. The proposed performance monitoring plan for Byron Unit 2 will be performed by the end of 2034. This will ensure that no more than 20 years elapses between the performance of an ASME XI examination for the Category B-B and B-D components included in the performance monitoring plan.

Unit	ASME Category	ASME Item	Component ID	Component Description
2	B-B	B2.11	2RY-01-S/PC-05	Shell – Upper Head
2	B-B	B2.12	2RY-01-S/PL-04	Upper Longitudinal Weld
2	B-D	B3.110	2RY-01-S/PN-02	Spray Nozzle
2	B-D	B3.110	2RY-01-S/PN-03	Relief Nozzle
2	B-D	B3.110	2RY-01-S/PN-04	Safety Nozzle
2	B-D	B3.110	2RY-01-S/PN-05	Safety Nozzle
2	B-D	B3.110	2RY-01-S/PN-06	Safety Nozzle

With the proposed performance monitoring plan by CEG, seven (7) of the ten (10) Byron Unit 2 pressurizer components covered by the proposed alternative will receive an ASME XI inspection during the analytically determined safe operating period. Given that the proposed performance monitoring plan includes at least one weld from each ASME XI Category and Item Number combination, examination of 7 of 10 welds for the Byron Unit 2 pressurizer is considered an adequate sample to identify any new or unexpected degradation mechanisms in the remaining pressurizer components. The components selected for examination as part of the performance monitoring plan are considered representative of the remaining components covered by the proposed alternative given the similarities in design, materials, construction methods, service conditions, and operating strategies between Byron and Braidwood. Given the number of examinations (seven) and the representative nature of the components selected, the performance monitoring plan is considered to adequately represent the material condition of the remaining components covered by the proposed alternative at Byron and Braidwood.

Performing an ASME Section XI volumetric examination of the components included in the performance monitoring plan by the specified date will provide direct evidence to the presence of, or extent of, any unexpected degradation experienced by these components. Due to similarities between the components and operating conditions at Byron and Braidwood, the results of the performance monitoring plan for Byron Unit 2 are considered to accurately represent the material condition for the same components in Byron Unit 1 as well as Braidwood Units 1 and 2.

In the unlikely event of any new unacceptable indications (i.e., indications exceeding the acceptance standards of IWB-3500, that are accepted by Repair/Replacement Activity or Analytical Evaluation) are identified during the performance monitoring plan at Byron Unit 2, these indications will be evaluated as required by ASME Section XI and the corrective action program. The additional examination and successive inspection requirements of ASME Section XI also apply. Any new unacceptable indications identified as part of the performance monitoring plan at Byron Unit 2 will result in the same population of welds being examined at Byron Unit 1 and Braidwood Units 1 and 2 during the next regularly scheduled refueling outage.

In addition to the direct evidence provided by the performance monitoring plan, examination of Category B-B and Category B-D pressurizer components is expected to continue to be performed by other units across the domestic and international PWR fleet. These examinations will provide additional monitoring and opportunities to detect any degradation in the components covered by the proposed alternative. Continued examination of Category B-B and Category B-D pressurizer components across the industry will provide additional opportunities to detect known degradation mechanisms, as described in Section 6.0 of the EPRI report, and will also provide the opportunity to detect any new or unexpected degradation mechanisms that may occur in the future for the subject components. If a new degradation mechanism is identified during continued industry examinations, CEG will follow the industry guidance to address this new degradation mechanism.

The absence of any new unacceptable indications in the Byron Unit 2 components selected for examination as part of the performance monitoring plan and the absence of any unexpected degradation across the operating fleet, provides validation that the assumptions

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and methods of the PFM Model used in EPRI Report are adequate to predict the future behavior of the subject components. The strong technical basis provided by the results of the PFM Model and EPRI Report along with the implementation of the proposed performance monitoring plan, including scope expansion criteria, will provide additional assurance that the pressurizer welds at Byron and Braidwood can operate safely for the remainder of plant life and will continue to provide an acceptable level of quality and safety.

A regulatory commitment is contained in the Attachment.

Should you have any questions concerning this matter, please contact Tom Loomis at (610) 765-5510.

Respectfully,

David T. Gudger

David T. Gudger
Senior Manager - Licensing
Constellation Energy Generation, LLC

Attachment: Summary of Commitments

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

Attachment

Summary of Commitments

The following table identifies commitments made in this document. (Any other actions discussed in the submittal represent intended or planned actions. They are described to the NRC for the NRC's information and are not regulatory commitments.)

COMMITMENT	COMMITTED DATE OR "OUTAGE"	COMMITMENT TYPE	
		ONE-TIME ACTION (Yes/No)	Programmatic (Yes/No)
<p>As part of the performance monitoring plan, CEG will examine the following components at Byron Station, Unit 2 to the maximum extent possible:</p> <ul style="list-style-type: none"> • One (1) Category B-B, Item B2.11 top head circumferential weld • One (1) Category B-B, Item B2.12 top head longitudinal weld • Five (5) Category B-D, Item B3.110 nozzle to vessel welds consisting of: <ul style="list-style-type: none"> ○ One (1) spray nozzle ○ One (1) relief nozzle ○ Three (3) safety nozzles <p>The components to be examined are provided in the Table below.</p> <p>Any new unacceptable indications identified as part of the performance monitoring plan at Byron Unit 2 will result in the same population of welds being examined at Byron Unit 1 and Braidwood Unit 1 and 2 during the next regularly scheduled refueling outage.</p>	<p>The required examinations will be completed by the end of 2034 to ensure that no more than 20 years elapses between the performance of an ASME XI examination for the Category B-B and B-D components covered by the proposed alternative.</p>	Yes	No

Unit	ASME Category	ASME Item	Component ID	Component Description
2	B-B	B2.11	2RY-01-S/PC-05	Shell – Upper Head
2	B-B	B2.12	2RY-01-S/PL-04	Upper Longitudinal Weld
2	B-D	B3.110	2RY-01-S/PN-02	Spray Nozzle
2	B-D	B3.110	2RY-01-S/PN-03	Relief Nozzle
2	B-D	B3.110	2RY-01-S/PN-04	Safety Nozzle
2	B-D	B3.110	2RY-01-S/PN-05	Safety Nozzle
2	B-D	B3.110	2RY-01-S/PN-06	Safety Nozzle