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10 CFR 50.55a

RS-21-056

May 12, 2021

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

Calvert Cliffs Nuclear Power Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
NRC Docket Nos. 50-317 and 50-318

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

In accordance with 10 CFR 50.55a(z)(1), Exelon Generation Company, LLC (Exelon) hereby requests NRC approval of a proposed alternative to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," on the basis that the proposed alternative provides an acceptable level of quality and safety. Specifically, Exelon is requesting an alternative to volumetric examination of pressurizer circumferential and longitudinal shell-to-head welds and nozzle-to-shell welds to extend the inspection frequency from 10 years to the remainder of the currently licensed operating periods for Braidwood Generating Station (Braidwood), Units 1 and 2, Byron Generating Station (Byron), Units 1 and 2, and Calvert Cliffs Nuclear Power Plant (Calvert Cliffs), Units 1 and 2.

Proposed Alternative I4R-15 for Braidwood, I4R-21 for Byron, and ISI-05-016 for Calvert Cliffs is provided in Attachment 1. Exelon requests approval of the proposed alternative by March 1, 2022 to support the Spring 2022 outage season when some of the subject examinations are currently scheduled.

There are no regulatory commitments contained in this letter.

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

Respectfully,

David T. Gudger

David T. Gudger
Senior Manager - Licensing
Exelon Generation Company, LLC

Attachment 1: 10 CFR 50.55a Proposed Alternative I4R-15 for Braidwood Station, Units 1 and 2, Proposed Alternative I4R-21 for Byron Station, Units 1 and 2, and Proposed Alternative ISI-05-016 for Calvert Cliffs Nuclear Power Plant, Units 1 and 2, Revision 0

cc: Regional Administrator - NRC Region I
Regional Administrator - NRC Region III
NRC Senior Resident Inspector - Braidwood Station
NRC Senior Resident Inspector - Byron Station
NRC Senior Resident Inspector - Calvert Cliffs Nuclear Power Plant
NRC Project Manager - Braidwood Station
NRC Project Manager - Byron Station
NRC Project Manager - Calvert Cliffs Nuclear Power Plant
Illinois Emergency Management Agency – Division of Nuclear Safety
S. Seaman, State of Maryland

Attachment 1

**10 CFR 50.55a Proposed Alternative I4R-15 for Braidwood Station, Units 1 and 2,
Proposed Alternative I4R-21 for Byron Station, Units 1 and 2, and
Proposed Alternative ISI-05-016 for Calvert Cliffs Nuclear Power Plant, Units 1 and 2,
Revision 0**

Proposed Alternative for Examination of Pressurizer Shell-to-Head and Nozzle-to-Shell Welds (Examination Categories B-B and B-D) In Accordance with 10 CFR 50.55a(z)(1)

1 ASME Code Component(s) Affected

Code Class:	Class 1
Description:	Pressurizer Shell-to-Head and Nozzle-to-Vessel Welds
Examination Categories:	Category B-B, Pressure-Retaining Welds in Vessels Other Than Reactor Vessels Category B-D, Full Penetration Welded Nozzles in Vessels
Item Numbers:	B2.11 – Pressurizer, Shell-to-Head Welds, Circumferential B2.12 – Pressurizer, Shell-to-Head Welds, Longitudinal B3.110 – Pressurizer, Nozzle-to-Vessel Welds

Braidwood Component IDs:

Unit	ASME Category	ASME Item	Component ID	Component Description
1	B-B	B2.11	1PZR-01-08A	Shell – Lower Head
1	B-B	B2.11	1PZR-01-08E	Shell – Upper Head
2	B-B	B2.11	2PZR-01-08A	Shell – Lower Head
2	B-B	B2.11	2PZR-01-08E	Shell – Upper Head
1	B-B	B2.12	1PZR-01-09A	Shell Longitudinal Weld
1	B-B	B2.12	1PZR-01-09D	Shell Longitudinal Weld
2	B-B	B2.12	2PZR-01-09A	Shell Longitudinal Weld
2	B-B	B2.12	2PZR-01-09D	Shell Longitudinal Weld
1	B-D	B3.110	1PZR-01-N1	Surge Nozzle
1	B-D	B3.110	1PZR-01-N2	Spray Nozzle
1	B-D	B3.110	1PZR-01-N3	Relief Nozzle
1	B-D	B3.110	1PZR-01-N4A	Safety Nozzle
1	B-D	B3.110	1PZR-01-N4B	Safety Nozzle
1	B-D	B3.110	1PZR-01-N4C	Safety Nozzle
2	B-D	B3.110	2PZR-01-N1	Surge Nozzle
2	B-D	B3.110	2PZR-01-N2	Spray Nozzle
2	B-D	B3.110	2PZR-01-N3	Relief Nozzle
2	B-D	B3.110	2PZR-01-N4A	Safety Nozzle
2	B-D	B3.110	2PZR-01-N4B	Safety Nozzle
2	B-D	B3.110	2PZR-01-N4C	Safety Nozzle

Byron Component IDs:

Unit	ASME Category	ASME Item	Component ID	Component Description
1	B-B	B2.11	1RY-01-S/PC-01	Shell – Bottom Head
1	B-B	B2.11	1RY-01-S/PC-05	Shell – Upper Head
2	B-B	B2.11	2RY-01-S/PC-01	Shell – Bottom Head
2	B-B	B2.11	2RY-01-S/PC-05	Shell – Upper Head
1	B-B	B2.12	1RY-01-S/PL-01	Lower Longitudinal Weld
1	B-B	B2.12	1RY-01-S/PL-04	Upper Longitudinal Weld
2	B-B	B2.12	2RY-01-S/PL-01	Lower Longitudinal Weld
2	B-B	B2.12	2RY-01-S/PL-04	Upper Longitudinal Weld
1	B-D	B3.110	1RY-01-S/PN-01	Surge Nozzle
1	B-D	B3.110	1RY-01-S/PN-02	Spray Nozzle
1	B-D	B3.110	1RY-01-S/PN-03	Relief Nozzle
1	B-D	B3.110	1RY-01-S/PN-04	Safety Nozzle
1	B-D	B3.110	1RY-01-S/PN-05	Safety Nozzle
1	B-D	B3.110	1RY-01-S/PN-06	Safety Nozzle
2	B-D	B3.110	2RY-01-S/PN-01	Surge Nozzle
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

Calvert Cliffs Component IDs:

Unit	ASME Category	ASME Item	Component ID	Component Description
1	B-B	B2.11	3-401	Shell – Lower Head
1	B-B	B2.11	8-411	Shell – Upper Head
2	B-B	B2.11	3-401	Shell – Lower Head
2	B-B	B2.11	8-411	Shell – Upper Head
1	B-B	B2.12	2-401A	Upper Shell At 270 Deg.
1	B-B	B2.12	2-401B	Upper Shell At 90 Deg.
1	B-B	B2.12	2-401C	Lower Shell At 180 Deg.
1	B-B	B2.12	2-401D	Lower Shell At 0 Deg.
2	B-B	B2.12	2-401A	Upper Shell At 270 Deg.
2	B-B	B2.12	2-401B	Upper Shell At 90 Deg.
2	B-B	B2.12	2-401C	Lower Shell At 180 Deg.
2	B-B	B2.12	2-401D	Lower Shell At 0 Deg.
1	B-D	B3.110	4-404	Surge Nozzle
1	B-D	B3.110	4-405	Spray Nozzle
1	B-D	B3.110	16-405A	Safety & Relief Nozzle
1	B-D	B3.110	16-405B	Safety & Relief Nozzle
2	B-D	B3.110	4-404	Surge Nozzle
2	B-D	B3.110	4-405	Spray Nozzle
2	B-D	B3.110	16-405A	Safety & Relief Nozzle
2	B-D	B3.110	16-405B	Safety & Relief Nozzle

2 Applicable Code Edition and Addenda

The following table identifies the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Section XI Code of Record for performing Inservice Inspection (ISI) activities at Braidwood, Byron, and Calvert Cliffs:

PLANT	INTERVAL	EDITION	START	END
Braidwood Station, Units 1 and 2	Fourth	2013 Edition	August 29, 2018 (Unit 1) November 5, 2018 (Unit 2)	July 28, 2028 (Unit 1) October 16, 2028 (Unit 2)
Byron Station, Units 1 and 2	Fourth	2007 Edition, through 2008 Addenda	July 16, 2016	July 15, 2025
Calvert Cliffs Nuclear Power Plant, Units 1 and 2	Fifth	2013 Edition	July 1, 2019	June 30, 2029

The 2019 Edition of ASME Section XI, Table G-2110-1 will be utilized to extend the use of Figure G-2110-1, Reference Critical Stress Intensity Factor for Material, to material SA-533 Grade A, Class 2. (Note: The 2019 Edition of ASME Section XI is published in the proposed rules of the Federal Register, Vol. 86, No. 57. Currently there are conditions in the proposed NRC Rulemaking (86 FR 16087) regarding Table G-2110-1, but these conditions do not pertain to the use of Table G-2110-1 for material SA-533 Grade A, Class 2 as used in this proposed alternative).

3 Applicable Code Requirement

ASME Code, Section XI, IWB-2500(a), Table IWB-2500-1, Examination Category B-B, requires examination of the applicable Item Numbers as follows:

> Item No. B2.11 - Volumetric examination of both Circumferential Shell-to-Head welds during each inspection interval. The examination volume is shown in Figure IWB-2500-1.
>
> Item No. B2.12 - Volumetric examination of one foot of one Longitudinal Shell-to-Head weld intersecting the circumferential weld per head each inspection interval. The examination volume is shown in Figure IWB-2500-2.

ASME Code, Section XI, IWB-2500(a), Table IWB-2500-1, Examination Category B-D, requires examination of the applicable Item Number as follows:

> Item No. B3.110 - Volumetric examination of all Full Penetration Nozzle-to-Vessel welds during each inspection interval. The examination volume is shown in Figures IWB-2500-7(a), (b), (c), and (d).

4 Reason for Request

The Electric Power Research Institute (EPRI) performed assessments in Reference [1] of the basis for the ASME Section XI examination requirements specified for the above-listed ASME Code, Section XI, Division 1 (ASME Section XI) Examination Categories and Item Numbers for pressurizer welds. The assessments include a survey of inspection results from 74 units as well as flaw tolerance evaluations using probabilistic fracture mechanics (PFM) and deterministic fracture mechanics (DFM). The Reference [1] report results indicate that the current ASME Section XI inspection interval of ten years for these welds can be increased with no impact to plant safety. It is upon the basis of those results that an alternate inspection interval is requested.

5 Proposed Alternative and Basis for Use

Exelon requests an inspection alternative to the examination requirements of ASME Section XI, Table IWB-2500-1, for Examination Categories B-B and B-D, Item Numbers B2.11, B2.12, and B3.110. The proposed alternative is to defer inspection of these Item Numbers from the current ASME Section XI 10-year requirement to the end of the currently approved Period of Extended Operation (PEO) for Braidwood Station (Braidwood), Units 1 and 2, Byron Station (Byron), Units 1 and 2, and Calvert Cliffs Nuclear Power Plant (Calvert Cliffs), Units 1 and 2, as summarized in the following table.

Table 1. Summary of Inspection Deferrals in this Proposed Alternative

Station	Unit	ASME Category	Item No.	Description	Date of Last Inspection	End of Current Licensed Operating Period (60 Years)	Length of Time Until Next Inspection for This Request (Years)
Braidwood	1	B-B	B2.11	Pressurizer, Shell-to-Head Welds, Circumferential	10/12/2019	10/17/2046	27.0
		B-B	B2.12	Pressurizer, shell-to-Head Welds, Longitudinal	10/12/2019		27.0
		B-D	B3.110	Pressurizer, Nozzle-to-Vessel Welds	4/8/2021		25.0
Braidwood	2	B-B	B2.11	Pressurizer, Shell-to-Head Welds, Circumferential	10/11/2018	12/18/2047	29.2
		B-B	B2.12	Pressurizer, shell-to-Head Welds, Longitudinal	10/11/2018		29.2
		B-D	B3.110	Pressurizer, Nozzle-to-Vessel Welds	10/11/2018		29.2
Byron	1	B-B	B2.11	Pressurizer, Shell-to-Head Welds, Circumferential	9/18/2015	10/31/2044	29.1
		B-B	B2.12	Pressurizer, shell-to-Head Welds, Longitudinal	9/18/2015		29.1
		B-D	B3.110	Pressurizer, Nozzle-to-Vessel Welds	9/14/2018		26.1
Byron	2	B-B	B2.11	Pressurizer, Shell-to-Head Welds, Circumferential	10/6/2014	11/6/2046	32.1
		B-B	B2.12	Pressurizer, shell-to-Head Welds, Longitudinal	10/6/2014		32.1
		B-D	B3.110	Pressurizer, Nozzle-to-Vessel Welds	4/13/2019		27.6
Calvert Cliffs	1	B-B	B2.11	Pressurizer, Shell-to-Head Welds, Circumferential	2/25/2020	7/31/2034	14.4
		B-B	B2.12	Pressurizer, shell-to-Head Welds, Longitudinal	2/25/2020		14.4
		B-D	B3.110	Pressurizer, Nozzle-to-Vessel Welds	2/21/2016		18.5
Calvert Cliffs	2	B-B	B2.11	Pressurizer, Shell-to-Head Welds, Circumferential	3/13/2021	8/13/2036	15.4
		B-B	B2.12	Pressurizer, shell-to-Head Welds, Longitudinal	3/12/2021		15.4
		B-D	B3.110	Pressurizer, Nozzle-to-Vessel Welds	3/10/2021		15.4

As indicated in Table 1, the proposed alternative results in a maximum effective operating period of 32.1 years from the last inspection for Item Numbers B2.11 and B2.12 for Byron Unit 2 included in this proposed alternative. As summarized in Reference [1], the EPRI report demonstrates that for time intervals longer than 30 years (up to 80 years) no other inspections are required to maintain plant safety and relevant acceptance criteria.

The key aspects of the technical basis for this request are summarized below. The applicability of the technical basis to Braidwood, Byron, and Calvert Cliffs is shown in Appendix A.

Degradation Mechanism Evaluation

An evaluation of degradation mechanisms that could potentially impact the reliability of the pressurizer welds was performed in Reference [1]. Evaluated mechanisms included stress corrosion cracking (SCC), environmental assisted fatigue (EAF), microbiologically influenced corrosion (MIC), pitting, crevice corrosion, erosion-cavitation, erosion, flow accelerated corrosion (FAC), general corrosion, galvanic corrosion, and mechanical/ thermal fatigue. Other than the potential for EAF and mechanical/thermal fatigue, there are no active degradation mechanisms identified that significantly affect the long-term structural integrity of the pressurizer welds.

Stress Analysis

Finite element analyses (FEA) were performed in Reference [1] to determine the stresses in the subject pressurizer welds. The analyses were performed using representative pressurized water reactor (PWR) geometries, representative transients, and typical material properties. The results of the stress analyses were used to produce flaw tolerance evaluations. The applicability of the FEA to Braidwood, Byron, and Calvert Cliffs in accordance with Section 9 of Reference [1] is shown in Appendix A and confirms that all plant-specific applicability requirements are satisfied. Therefore, the evaluation results and conclusions of Reference [1] are applicable to Braidwood, Byron, and Calvert Cliffs.

Flaw Tolerance Evaluation

Flaw tolerance evaluations were performed in Reference [1] consisting of PFM and DFM evaluations. The results of the PFM analyses indicate that, after a preservice inspection (PSI), no other inspections are required for up to 60 years of plant operation to meet the U.S. Nuclear Regulatory Commission's (NRC's) safety goal of 10^{-6} failures per year. For the case of Braidwood and Byron, PSI was followed by three full 10-year interval inspections, which have been performed on the subject pressurizer welds. For Calvert Cliffs, PSI was followed by four full 10-year interval inspections, which have been performed on the subject pressurizer welds. Table 8-12 of Reference [1] indicates that if PSI are followed by at least three full 10-year interval inspections subsequent examinations do not need to be performed for up to 80 years of plant operation, and they will still meet the NRC safety goal (with considerable margin). The DFM evaluations confirm the PFM results by demonstrating that it takes approximately 400 years for a postulated flaw with an initial depth equal to the ASME Section XI acceptance standards to grow to 80% of the wall thickness without exceeding the ASME Section XI allowable fracture toughness.

Inspection History

Plant operating experience (including examinations performed to-date, examination findings, inspection coverage, and previously submitted Proposed Alternatives) is summarized in Tables 2 through 4. As shown in these tables, some previous examinations for the subject welds had limited coverage because of limited volumetric examination scan access due to existing plant obstructions.

Table 2. Braidwood Station, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)
1	1PZR-01-08E BRW-1-B02.11.0005 B-B/B2.11	**8-1985 Coverage was not documented; but obstructions noted/NRI**	**10-1995/A1R05 100%/NRI**	**4-2006/A1R12 100%/NRI**	**9-2016/A1R19 98.5%/NRI**	**Examination currently scheduled for A2R25 (2025)**
1	1PZR-01-08A BRW-1-B02.11.0006 B-B/B2.11	**8-1985 100%/Laminar type flaws noted**	**10-1989/A1R01 100%/NRI**	**9-1998/A1R07 95.3%/NRI**	**4-2009/A1R14 95.3%/NRI**	**10-2019/A1R21 95.3%/NRI**
1	1PZR-01-09A BRW-1-B02.12.0005 B-B/B2.12	**8-1985 100%/Laminations/slag**	**10-1989/A1R01 100%/NRI**	**10-1998/A1R07 100%/NRI**	**4-2009/A1R14 100%/NRI**	**10-2019/A1R21 100%/NRI**
1	1PZR-01-09D BRW-1-B02.12.0006 B-B/B2.12	**8-1985 100%/NRI**	**10-1995/A1R05 100%/NRI**	**4-2006/A1R12 100%/NRI**	**9-2016/A1R19 100%/NRI**	**Examination currently scheduled for A2R25 (2025)**
1	1PZR-01-N4A BRW-1-B03.110.0013 B-D/B3.110	**8-1985 Coverage was not documented; limitations due to Geometry/NRI**	**10-1995/A1R05[3] Coverage was not documented/NRI**	**4-2006/A1R12 100% Shell Side only due to config/NRI**	**9-2016/A1R19 68.7%/NRI**	**Examination currently scheduled for A2R25 (2025)**
1	1PZR-01-N4B BRW-1-B03.110.0014 B-D/B3.110	**8-1985 Coverage was not documented; limitations due to Geometry/Laminar flaw**	**10-1995/A1R05 100%/NRI**	**10-2004/A1R11 92.66%/NRI**	**4-2015/A1R18 90.9%/NRI**	**Examination currently scheduled for A2R24 (2024)**
1	1PZR-01-N1 BRW-1-B03.110.0015 B-D/B3.110	**8-1985 Coverage was not documented; limitations due to Geometry/NRI**	**A1R06 (VT-2 per Relief Request per NR-24)**	**10-2007/A1R13[2] 59.2%/NRI**	**9-2016/A1R19[2] 74.7%/NRI**	**Examination currently scheduled for A2R25 (2025)**
1	1PZR-01-N2 BRW-1-B03.110.0016 B-D/B3.110	**8-1985 Coverage was not documented; limitations due to Geometry/NRI**	**10-1989/A1R01[3] Coverage was not documented/NRI**	**9-1998/A1R07[3] Coverage was not documented; geometry limitations/NRI**	**10-2010/A1R15 56.56%/NRI**	**4-2021/A1R22 56.43%/NRI**
1	1PZR-01-N3 BRW-1-B03.110.0017 B-D/B3.110	**8-1985 Coverage was not documented; limitations due to Geometry/NRI**	**10-1989/A1R01[3] Coverage was not documented/NRI**	**9-1998/A1R07[3] Coverage was not documented; geometry limitations/NRI**	**10-2010/A1R15 60.92%/NRI**	**4-2021/A1R22 60%/NRI**
1	1PZR-01-N4C BRW-1-B03.110.0018 B-D/B3.110	**8-1985 Coverage was not documented; limitations due to Geometry/NRI**	**10-1995/A1R05[3] Coverage was not documented; geometry limitations/NRI**	**10-2004/A1R11 92.66%/NRI**	**4-2015/A1R18 90.9%/NRI**	**Examination currently scheduled for A2R24 (2024)**
2	2PZR-01-08A BRW-2-B02.11.0005 B-B/B2.11	**1-1987 Coverage was not documented; limitations due to obstructions/ Laminar and Planar flaws noted**	**4-1990/A2R01[3] Coverage was not documented/NRI**	**5-1999/A2R07 99.85%/Laminations noted**	**10-2009/A2R14 95.57%/NRI**	**Examination currently scheduled for A2R23 (2023)**

Table 2. Braidwood Station, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)
2	2PZR-01-08E BRW-2-B02.11.0006 B-B/B2.11	**12-1986 Coverage was not documented; obstructions noted/Laminar and Planar flaws noted**	**4-1996/A2R05 100%/NRI**	**10-2006/A2R12 100%/NRI**	**10-2018/A2R20 100%/NRI**	**Examination currently scheduled for A2R26 (2027)**
2	2PZR-01-09A BRW-2-B02.12.0005 B-B/B2.12	**1-1987 100%/NRI**	**4-1990/A2R01 100%/NRI**	**5-1999/A2R07 100%/NRI**	**10-2009/A2R14 100%/NRI**	**Examination currently scheduled for A2R22 (2021)**
2	2PZR-01-09D BRW-2-B02.12.0006 B-B/B2.12	**12-1986 100%/Laminar type flaws noted**	**4-1996/A2R05 100%/NRI**	**10-2006/A2R12 100%/NRI**	**10-2018/A2R20 100%/NRI**	**Examination currently scheduled for A2R26 (2027)**
2	2PZR-01-N1 BRW-2-B03.110.0013 B-D/B3.110	**1-1987 100%/NRI**	**A2R06 (VT-2 per Relief Request NR-24)**	**5-2008/A2R13 59.2%/NRI**	**4-2017/A2R19[2] 59.2%/NRI**	**Examination currently scheduled for A2R25 (2026)**
2	2PZR-01-N2 BRW-2-B03.110.0014 B-D/B3.110	**12-1986 100%/NRI**	**4-1996/A2R05 100%/NRI**	**4-1999/A2R07 88.5%/NRI**	**4-2011/A2R15 88.5%/NRI**	**Examination currently scheduled for A2R23 (2023)**
2	2PZR-01-N3 BRW-2-B03.110.0015 B-D/B3.110	**12-1986 Coverage was not documented; geometry limitations/NRI**	**4-1990/A2R01[3] Coverage was not documented; geometry limitations /NRI**	**4-1999/A2R07 88.5%/NRI**	**4-2011/A2R15 88.5%/NRI**	**Examination currently scheduled for A2R22 (2021)**
2	2PZR-01-N4A BRW-2-B03.110.0016 B-D/B3.110	**12-1986 Coverage was not documented; nozzle geometry limitations/NRI**	**4-1990/A2R01[3] Coverage was not documented; geometry limitations /NRI**	**10-2006/A2R12 91.5%/NRI**	**10-2018/A2R20 91.5%/NRI**	**Examination currently scheduled for A2R26 (2027)**
2	2PZR-01-N4B BRW-2-B03.110.0017 B-D/B3.110	**12-1986 Coverage was not documented; nozzle geometry limitations /Laminar type flaw**	**3-1996/A2R05[3] Coverage was not documented; geometry limitations /NRI**	**11-2003/A2R10 88.5%/NRI**	**5-2014/A2R17 88.5%/NRI**	**Examination currently scheduled for A2R24 (2024)**
2	2PZR-01-N4C BRW-2-B03.110.0018 B-D/B3.110	**12-1986 Coverage was not documented; nozzle geometry limitations /NRI**	**3-1996/A2R05[3] Coverage was not documented; geometry limitations /NRI**	**11-2003/A2R10[3] Coverage was not documented; geometry limitations/NRI**	**5-2014/A2R17 88.5%/NRI**	**Examination currently scheduled for A2R24 (2024)**

Notes:

1. PSI included radiographic (RT) examinations per Section III and ultrasonic (UT) examinations per Section XI. Together, these examinations constituted “PSI examination” in Reference [1], and 100% coverage was assumed because such coverage was required by Section III for the RT exams, and the RT exams were successfully completed for the subject pressurizer welds for both Braidwood, Units 1 and 2.
2. The increase in examination coverage from the Second Interval to the Third Interval for weld 1PZR-01-N1 was not a result of a change in physical limitations, but was due to a change in the methods of calculating coverage. For Unit 1 the actual coverage reported in 2007 (A1R13) utilized the most conservative angle for the total coverage (60° axial = 59.2%). In 2016 (A1R19) the coverage utilized an aggregate of all angles 0°, 45° axial and circumferential and 60° axial and circumferential to achieve 74.7% coverage. For Unit 2 during the exam in 2017 (A2R19) for the similar weld, 2PZR-01-N1, coverage was not

recalculated, and the same coverage was recorded as the prior interval examination. The limitations are the same between Unit 1 and Unit 2 and the reported Third Interval coverage for weld 2PZR-01-N1 should be similar to the Unit 1 Third Interval coverage at 74.7%.

3. Exelon has reviewed the missing coverages for the examinations in the First and Second Intervals and has concluded that the NDE code requirements and equipment for early interval examinations would not have resulted in an examination coverage lower than the minimum achieved coverage of 56.43%. In addition, there have been no design configuration changes that would alter examination access for any of the welds.

During the Fourth Interval, the Braidwood, Unit 1, pressurizer spray nozzle weld 1PZR-01-N2 had the minimum coverage of 56.43%. Section 8.3.5 and Table 8-33 of Reference [1] discuss the limited coverage and show that the conclusions of the report are applicable to components with limited coverage as low as 50%. The minimum coverage of 56.43% for this weld is higher than the 50% minimum coverage assumed in the sensitivity study of the base case in the EPRI report; therefore, the sensitivity results from the EPRI report are bounding for application to Braidwood, Units 1 and 2.

No flaws that exceeded the ASME Section XI acceptance standards were identified during any prior examinations for Braidwood.

Table 3. Byron Station, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)
1	1RY-01-S/PC-01[2] BYR-1-B2.11.0001 B-B/B2.11	**8-1983 Coverage was not documented; scan limitations (welded pads) were identified/ 2 rejectable 45° indications and 3 rejectable 60° indications (total of 5 indications that did not meet the requirements of ASME Section XI, IWB-3511**	**4-1987 & 4-1987/B1R01[4] Coverage was not documented; scan limitations due to sampling nozzles and "X" axis plates/ Resizing of 5 subsurface indications identified in PSI 1-1990/B1R03 Resizing of 5 subsurface indications identified in B1R01 4-1996/B1R07 Resizing of 5 subsurface indications identified in B1R03**	**3-2002/B1R11 92%/5 embedded indications identified (1 with 45° and 4 with 60°) Fourth exam showed no change in indication sizes.**	**3-2011/B1R17 92%/NRI**	**Examination currently scheduled for B1R25 (2023)**
1	1RY-01-S/PC-05 BYR-1-B2.11.0002 B-B/B2.11	**8-1982 Coverage was not documented; scan limitations (welded pads) were identified/NRI**	**4-1996/B1R07 96%/NRI**	**3-2005/B1R13 96%/NRI**	**9-2015/B1R20 95.47%/NRI**	**Examination currently scheduled for B1R25 (2023)**
1	1RY-01-S/PL-01 BYR-1-B2.12.0001 B-B/B2.12	**8-1982 Coverage was not documented; no scan limitations were identified/NRI**	**4-1987/B1R01 90% - limited by sample nozzles and axis plates/NRI**	**3-2002/B1R11 100%/NRI**	**3-2011/B1R17 100%/NRI**	**Examination currently scheduled for B1R25 (2023)**
1	1RY-01-S/PL-04 BYR-1-B2.12.0002 B-B/B2.12	**8-1982 Coverage was not documented; no scan limitations were identified/NRI**	**4-1996/B1R07 100%/NRI**	**3-2005/B1R13 100%/NRI**	**9-2015/B1R20 100%/NRI**	**Examination currently scheduled for B1R25 (2023)**
1	1RY-01-S/PN-01 BYR-1-B3.110.0001 B-D/B3.110	**7-1982 Coverage was not documented; no scan limitations were identified/NRI**	**B1R07 (VT-2 per Relief Request NR-19)**	**B1R11 (VT-2 per Relief Request I2R-03)**	**9-2006/B1R14[3] 40% - limited by nozzle configuration and heater penetrations/NRI**	**9-2018/B1R22[3] 72.03% - limited by nozzle configuration and heater penetrations/NRI**

Table 3. Byron Station, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)
1	1RY-01-S/PN-02 BYR-1-B3.110.0002 B-D/B3.110	**7-1982 Coverage was not documented; no scan limitations were identified/ Indications – appears to be ID geometry**	**1-1990/B1R03 75% - limited by nozzle configuration/NRI with 0° and 45°. ID Geometry with 60°**	**11-1997/B1R08 73% - limited by nozzle configuration/NRI**	**9-2006/B1R14 77% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B1R26 (2024)**
1	1RY-01-S/PN-03 BYR-1-B3.110.0003 B-D/B3.110	**7-1982 Coverage was not documented; no scan limitations were identified/NRI**	**3-1987/B1R01 100%/NRI**	**11-1997/B1R08 69% - limited by nozzle configuration/NRI**	**9-2006/B1R14 77% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B1R26 (2024)**
1	1RY-01-S/PN-04 BYR-1-B3.110.0004 B-D/B3.110	**7-1982 Coverage was not documented; no scan limitations were identified Indications – appears to be ID geometry**	**1-1990/B1R03 75% - limited by nozzle configuration/NRI with 0° and 45°. ID Geometry with 60°**	**3-2002/B1R11 66% - limited by nozzle configuration/NRI**	**9-2015/B1R20 64.93% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B1R25 (2023)**
1	1RY-01-S/PN-05 BYR-1-B3.110.0005 B-D/B3.110	**7-1982 Coverage was not documented; no scan limitations were identified/NRI**	**4-1996/B1R07 100%/NRI**	**11-1997/B1R08 73% - limited by nozzle configuration/NRI**	**9-2006/B1R14 68% - limited by nozzle configuration/NRI 9-2015/B1R20 64.93% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B1R25 (2023)**
1	1RY-01-S/PN-06 BYR-1-B3.110.0006 B-D/B3.110	**7-1982 Coverage was not documented; no scan limitations were identified/ Indications – appears to be ID geometry and one spot indication (seen with 45°)**	**9-1988/B1R02 76% (0°) 75% (45°), 75% (60°) limited due to configuration/Spot indication similar to PSI**	**11-1997/B1R08 73% - limited by nozzle configuration/NRI**	**9-2006/B1R14 77% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B1R26 (2024)**
2	2RY-01-S/PC-01 BYR-2-B2.11.0001 B-B/B2.11	**10-1985 Coverage was not documented; scan limitations (welded pads, sampling nozzle and skirt) were identified/NRI**	**1-1989/B2R01[4] Coverage was not documented; scan limitations (welded pads, sampling nozzle and skirt) were identified/NRI**	**3-2004/B2R11 92% - scan limitations (welded pads, sampling nozzle and skirt)/NRI**	**10-2014/B2R18 94%/NRI**	**Examination currently scheduled for B2R23 (2022)**

Table 3. Byron Station, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)
2	2RY-01-S/PC-05 BYR-2-B2.11.0002 B-B/B2.11	**10-1985** **Coverage was not documented; scan limitations (welded pads) were identified/NRI**	**3-1995/B2R05[4]** **Coverage was not documented; scan limitations (welded pads) were identified/NRI**	**9-2005/B2R12** **96%/NRI**	**4-2010/B2R15** **96%/NRI**	**Examination currently scheduled for B2R24 (2023)**
2	2RY-01-S/PL-01 BYR-2-B2.12.0001 B-B/B2.12	**10-1985** **Coverage was not documented; no scan limitations were identified/** **Indications – 0° identified 4 embedded indications, 45° was NRI, 60° identified 2 embedded indications.**	**1-1989/B2R01[4]** **Coverage was not documented; no scan limitations were identified/NRI**	**3-2004/B2R11** **100%/NRI**	**10-2014/B2R18** **100%/NRI**	**Examination currently scheduled for B2R23 (2022)**
2	2RY-01-S/PL-04 BYR-2-B2.12.0002 B-B/B2.12	**10-1985** **Coverage was not documented; no scan limitations were identified/NRI**	**3-1995/B2R05[4]** **Coverage was not documented; no scan limitations were identified/NRI**	**9-2005/B2R12** **100%/NRI**	**4-2010/B2R15** **100%/NRI**	**Examination currently scheduled for B2R24 (2023)**
2	2RY-01-S/PN-01 BYR-2-B3.110.0001 B-D/B3.110	**10-1985** **Coverage was not documented; no scan limitations were identified/** **Indications – 0° was NRI, 45° identified 1 embedded indication, 60° identified 1 embedded indication.**	**2-1989/B2R01** **(VT-2 per Relief Request NR-19)**	**11-1999/B2R08** **(VT-2 per Relief Request I2R-03)**	**4-2007/B2R13[3]** **40% - limited by nozzle configuration and heater penetrations/NRI**	**4-2019/B2R21[3]** **40% - limited by nozzle configuration and heater penetrations/NRI**
2	2RY-01-S/PN-02 BYR-2-B3.110.0002 B-D/B3.110	**10-1985** **Coverage was not documented; no scan limitations were identified/NRI**	**9-1993/B2R04[4]** **Coverage was not documented; no scan limitations were identified/NRI**	**3-2004/B2R11** **62.3% - limited by nozzle configuration/NRI**	**4-2010/B2R15** **62.3% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B2R24 (2023)**
2	2RY-01-S/PN-03 BYR-2-B3.110.0003 B-D/B3.110	**10-1985** **Coverage was not documented; no scan limitations were identified/NRI**	**10-1990/B2R02** **75% - limited by nozzle configuration/NRI**	**4-2001/B2R09** **66% - limited by nozzle configuration/NRI**	**4-2010/B2R15** **66.3% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B2R24 (2023)**
2	2RY-01-S/PN-04 BYR-2-B3.110.0004 B-D/B3.110	**10-1985** **Coverage was not documented; no scan limitations were identified/NRI**	**9-1993/B2R04[4]** **Coverage was not documented; no scan limitations were identified/NRI**	**3-2004/B2R11** **62% - limited by nozzle configuration/NRI**	**10-2014/B2R18** **62.5% - limited by nozzle configuration/NRI**	**Examination currently scheduled for B2R24 (2023)**

Table 3. Byron Station, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)
2	2RY-01-S/PN-05 BYR-2-B3.110.0005 B-D/B3.110	**10-1985** **Coverage was not documented; no scan limitations were identified/NRI**	**3-1995/B2R05[4]** **Coverage was not documented; no scan limitations were identified/NRI**	**4-2001/B2R09** **66.3% - limited by nozzle configuration/NRI**	**10-2014/B2R18** **62.5% - limited by nozzle configuration/NRI**	**4-2019/B2R21** **66% - limited by nozzle configuration/NRI**
2	2RY-01-S/PN-06 BYR-2-B3.110.0006 B-D/B3.110	**10-1985** **Coverage was not documented; no scan limitations were identified/NRI**	**3-1995/B2R05[4]** **Coverage was not documented; no scan limitations were identified/NRI**	**4-2001/B2R09** **66% - limited by nozzle configuration/NRI**	**4-2010/B2R15** **66.3% - limited by nozzle configuration/NRI**	**4-2019/B2R21** **62% - limited by nozzle configuration/NRI**

Notes:

1. PSI included radiographic (RT) examinations per Section III and ultrasonic (UT) examinations per Section XI. Together, these examinations constituted “PSI examination” in Reference [1], and 100% coverage was assumed because such coverage was required by Section III for the RT exams, and the RT exams were successfully completed for the subject pressurizer welds for both Byron units.
2. Indications were found in weld 1RY-01-S/PC-01 that did not meet the acceptance standards of IWB-3511 during the initial PSI examination, but were accepted by engineering evaluation per IWB-3600 and three successive examinations were performed in B1R01, B1R03, and B1R07, which showed no changes in the flaw sizes.
3. The increase in examination coverage from the Third Interval to the Fourth Interval for weld 1RY-01-S/PN-01 was not a result of a change in physical limitations, but was due to a change in the methods of calculating coverage. For Unit 1 in 2018 (B1R22) the coverage calculated included the axial coverage of the examination which increased the coverage to 72.03%. For Unit 2 the exam in 2019 (B2R21) did not recalculate the coverage and conservatively assumed the same coverages as the 2007 (B2R13) exam, which did not include the axial coverage. The limitations are the same between Unit 1 and Unit 2 and the reported Fourth Interval coverage for weld 2RY-01-S/PN-01 should be similar to the Unit 1 Fourth Interval coverage at 72.03%.
4. Exelon has reviewed the missing coverages for the examinations in the First Interval and has concluded that the Code NDE requirements and equipment for early interval examinations would not have resulted in an examination coverage lower than the minimum documented coverage of 40%. In addition, there have been no design configuration changes that would alter examination access for any of the welds.

During Interval 3, the Byron, Units 1 and 2 pressurizer surge nozzle welds 1RY-01-S/PN-01 and 2RY-01-S/PN-01 had the minimum documented coverage of 40%. During Interval 4, the Byron, Unit 2 pressurizer surge nozzle weld 2RY-01-S/PN-01 again had a minimum documented coverage of 40%. (Note: The subsequent B1R22 examination for Weld ID 1RY-01-S/PN-01 recorded significantly more coverage at 72.03%, which was calculated by including the axial examination. The change in coverage was not a result of changes to physical limitations. The limitations are the same between Unit 1 and Unit 2 and the reported Fourth Interval coverage for weld 2RY-01-S/PN-01 should be similar to the Unit 1 Fourth Interval coverage at 72.03%). During the First and Second Intervals Relief Requests NR-19 and I2R-03 were approved by the NRC to perform VT-2 examination in lieu of UT for welds 1RY-01-S/PN-01 (Outage B1R07 and B1R11) and 2RY-01-S/PN-01 (Outages B2R01 and B2R08). Since the minimum coverage was identified for the surge line nozzle welds, a review of the probability of leakage and rupture for various sensitivity studies from Reference [1] was done for leak path PRNV-BW-1C, which is applicable to welds 1RY-01-S/PN-01 and 2RY-01-S/PN-01 as follows:

- Section 8.3.4.1.1 and Table 8-11 of Reference [1] discuss the probability of rupture and leakage for the case study if only PSI exams are performed. The most limiting crack path for the surge line nozzle welds (PRNV-BW-1C), yielded a probability of leakage of 6.25×10^{-9} after 80 years and a probability of rupture of 1.25×10^{-9} after 80 years. The probability of leakage and the probability of rupture for this Case ID listed in Table 8-11 are approximately three orders of magnitude below the acceptance criteria utilized in Reference [1], Section 8.3.2.9, of 10^{-6} failures per year. Additionally, the impact of performing more examinations than the PSI-only case study, even with limited coverage, which was the case for welds 1RY-01-S/PN-01 and 2RY-01-S/PN-01, would reduce the probability of rupture and leakage. Furthermore, as discussed in Section 8.3.4.1.1 of Reference [1], leakage of the pressure boundary is detectable by plant operators and plant procedures allow for safe plant shutdown under leaking conditions. Probabilities of rupture values are maintained well below the acceptance criterion for 80 years of operation even considering only PSI inspection. The examination results with coverage as low as 40% for welds 1RY-01-S/PN-01 and 2RY-01-S/PN-01 at Byron are bounded by the PSI-only case study in Reference [1] and the failure frequency for these welds would be below the NRC acceptance criteria of 10^{-6} failures per year.

- Section 8.3.5 and Table 8-33 of Reference [1] discuss the probability of leakage for the case study where only 50% coverage was achieved. For the leak path most applicable to welds 1RY-01-S/PN-01 and 2RY-01-S/PN-01, PRNV-BW-1C was evaluated to have a probability of leakage of 3.75×10^{-9} after 80 years. This was an increase of 2.5×10^{-9} compared to the base case where 100% coverage was achieved. This increase in the probability of leakage is small in comparison to the acceptance criteria of 10^{-6} failures per year. The sensitivity studies performed in Reference [1], including the Inspection Coverage case study, show that probabilities of rupture and leakage are not significantly affected by using a range of values for most of the input variables.

Considering all of the findings from Reference [1] it can be concluded that the probability of failure is below 10^{-6} failures per year for welds 1RY-01-S/PN-01 and 2RY-01-S/PN-01.

At Byron, weld 1RY-01-S/PC-01 had five indications that did not meet acceptance standards of IWB-3511 during the PSI examination, but all five indications were accepted through engineering evaluation in accordance with IWB-3600 of Section XI. Successive examinations were performed in B1R01 (1987), B1R03 (1990), and B1R07 (1996) which showed no change in the five indications. The most recent examination performed on weld 1RY-01-S/PC-01 during B1R17 (2011) did not identify any recordable indications. The absence of indications in this latest examination is due to improved NDE techniques and changes to sizing requirements. Therefore, the B1R17 examination determined that the previously reported indications meet the acceptance standards of ASME Section XI.

Based on the discussions above, the results of the EPRI report are applicable to Byron, Units 1 and 2.

Table 4. Calvert Cliffs, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)	Interval 5 (Date/Outage, Coverage/Results)
1	8-411 CCNP-1-003900 B-B/B2.11	**8-1974 Coverage was not documented/NRI**	**DATA RECORD NOT FOUND[5]**	**DATA RECORD NOT FOUND[5]**	**3-2000/1RFO14 100%/NRI**	**2-2010/1RFO19 100%/NRI**	**2-2020/CC1R25 99.7%/NRI**
1	3-401 CCNP-1-004000 B-B/B2.11	**8-1974 Coverage was not documented/ NRI**	**2-1978/1RFO2[6] Coverage was not documented /NRI**	**3-1994 /1RFO11 99.8%/NRI**	**4-2004/1RFO16 90.7%/NRI**	**2-2018/1RFO23 99.1%/NRI**	**Examination currently scheduled for CC1R29 (2028)**
1	2-401A CCNP-1-003700 B-B/B2.12	**8-1974 Coverage was not documented/ NRI**	**2-1978/1RFO2[6] Coverage was not documented /NRI**	**DATA RECORD NOT FOUND[5]**	**3-2000/1RFO14 96%/NRI**	**2-2010/1RFO19 100%/NRI**	**2-2020/CC1R25 97.5%/NRI**
1	2-401B CCNP-1-003750 B-B/B2.12	**8-1974 Coverage was not documented/ NRI**	**11-1980/1RFO4[6] Coverage was not documented /NRI**	**NA[4]**	**NA[4]**	**NA[4]**	**NA[4]**
1	2-401C CCNP-1-003800 B-B/B2.12	**71974 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**NA[4]**	**NA[4]**	**NA[4]**	**NA[4]**
1	2-401D CCNP-1-003850 B-B/B2.12	**9-1974 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**3-1994/1RFO11 100%/NRI**	**4-2004/1RFO16 100%/NRI**	**2-2018/1RFO23 94%/NRI**	**Examination currently scheduled for CC1R29 (2028)**
1	4-404 CCNP-1-004050 B-D/B3.110	**7-1974 Coverage was not documented/ NRI**	**11-1980/1RFO4[6] Coverage was not documented /NRI**	**2-1994/1RFO11 71%/NRI**	**4-2004/1RFO16[3] 65.9%/NRI**	**2-2014/1RFO21[3] 31.8%/NRI**	**Examination currently scheduled for CC1R28 (2026)**
1	4-405 CCNP-1-004100 B-D/B3.110	**8-1974 Coverage was not documented/ NRI**	**2-1978/1RFO2[6] Coverage was not documented /NRI**	**DATA RECORD NOT FOUND[5]**	**3-2000/1RFO14 66.4%/NRI**	**2-2010/1RFO19 66.4%/NRI**	**Examination currently scheduled for CC1R28 (2026)**
1	16-405A CCNP-1-004150 B-D/B3.110	**7-1974 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**DATA RECORD NOT FOUND[5]**	**2-2006/1RFO17[2] 36%/NRI**	**2-2016/1RFO22[2] 60.5%/NRI**	**Examination currently scheduled for CC1R28 (2026)**
1	16-405B CCNP-1-004200 B-D/B3.110	**7-1974 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**3-1994/1RFO11[2] 79.7%/NRI**	**2-2006/1RFO17[2] 36%/NRI**	**2-2016/1RFO22[2] 60.5%/NRI**	**Examination currently scheduled for CC1R28 (2026)**
2	8-411 CCNP-2-103050 B-B/B2.11	**9-1972 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**DATA RECORD NOT FOUND[5]**	**2RFO13 DATA RECORD NOT FOUND[5]**	**2-2011 /2RFO18 100%/NRI**	**3-2021/CC2R24 99.7%/NRI**
2	3-401 CCNP-2-103070 B-B/B2.11	**9-1972 Coverage was not documented/ NRI**	**6-1984/2RFO6[6] Coverage was not documented /NRI**	**4-1993/2RFO9 100%/NRI**	**3-2003/2RFO14 100%/NRI**	**2-2017/2RFO21 100%/NRI**	**Examination currently scheduled for CC2R27 (2027)**

Table 4. Calvert Cliffs, Units 1 and 2, Pressurizer Welds Inspection History

Unit	Weld ID Summary Number Exam Cat, Item Number	PSI[1] Ultrasonic Test (UT) (Date, Coverage/Results)	Interval 1 (Date/Outage, Coverage/Results)	Interval 2 (Date/Outage, Coverage/Results)	Interval 3 (Date/Outage, Coverage/Results)	Interval 4 (Date/Outage, Coverage/Results)	Interval 5 (Date/Outage, Coverage/Results)
2	2-401A CCNP-2-103010 B-B/B2.12	**9-1972 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**DATA RECORD NOT FOUND[5]**	**2RFO13 DATA RECORD NOT FOUND[5]**	**2-2011/2RFO18 96%/NRI**	**3-2021/CC2R24 96.4%/NRI**
2	2-401B CCNP-2-103020 B-B/B2.12	**9-1972 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**NA[4]**	**NA[4]**	**NA[4]**	**NA[4]**
2	2-401C CCNP-2-103030 B-B/B2.12	**9-1972 Coverage was not documented/ NRI**	**6-1984/2RFO6[6] Coverage was not documented /NRI**	**NA[4]**	**NA[4]**	**NA[4]**	**NA[4]**
2	2-401D CCNP-2-103040 B-B/B2.12	**9-1972 Coverage was not documented/ NRI**	**6-1984/2RFO6[6] Coverage was not documented /NRI**	**DATA RECORD NOT FOUND[5]**	**3-2003/2RFO14 100%/NRI**	**2-2017/2RFO21 95.3%/NRI**	**Examination currently scheduled for CC2R27 (2027)**
2	4-404 CCNP-2-103080 B-D/B3.110	**9-1972 Coverage was not documented/ NRI**	**DATA RECORD NOT FOUND[5]**	**4-1989/2RFO8 63%/NRI**	**4-2001/2RFO13 69.5%/NRI**	**2-2011/2RFO18[3] 56%/NRI**	**3-2021/CC2R24[3] 28.2%/NRI**
2	4-405 CCNP-2-103090 B-D/B3.110	**9-1972 Coverage was not documented/ NRI**	**6-1984/2RFO6[6] Coverage was not documented /NRI**	**4-1989/2RFO8 53%/NRI**	**2RFO13 DATA RECORD NOT FOUND[5]**	**2-2011/2RFO18 65%/NRI**	**3-2021/CC2R24 62.1%/NRI**
2	16-405A CCNP-2-103100 B-D/B3.110	**9-1972 Coverage was not documented/ NRI**	**6-1984/2RFO6[6] Coverage was not documented /NRI**	**4-1993/2RFO9[2] 98%/NRI**	**3-2003/2RFO14[2] 41%/NRI**	**2-2013/2RFO19[2] 58%/NRI**	**3-2021/CC2R24[2] 55.3%/NRI**
2	16-405B CCNP-2-103110 B-D/B3.110	**9-1972 Coverage was not documented/ NRI**	**6-1984/2RFO6[6] Coverage was not documented /NRI**	**DATA RECORD NOT FOUND[5]**	**3-2007/2RFO16[2] 41.9%/NRI**	**2-2017/2RFO21[2] 60.5%/NRI**	**3-2021/CC2R24[2] 55.3%/NRI**

Notes
1. PSI included radiographic (RT) examinations per Section III and ultrasonic (UT) examinations per Section XI. Together, these examinations constituted "PSI examination" in Reference [1], and 100% coverage was assumed because such coverage was required by Section III for the RT exams, and the RT exams were successfully completed for the subject pressurizer welds for both Calvert Cliffs units.
2. The variations in examination coverage over the Intervals for welds 16-405A and 16-405B (Units 1 and 2) was not a result of a change in physical limitations, but was due to a change in the methods of calculating coverage.
3. The decrease in examination coverage from the Third Interval to the Fourth Interval (Unit 1) and Fourth Interval to the Fifth Interval (Unit 2) for weld 4-404 was not a result of a change in physical limitations, but was due to a change in the examination boundaries. The weld locations utilized in 2004 (1RFO16) and 2011 (2RFO18) were adjusted in 2014 (1RFO21) and 2021 (2RFO24) to be closer to the nozzle, based on the nozzle design drawing, which increased the limitation. The adjustment resulted in a drop in coverage.
4. The pressurizers at Calvert Cliffs have two longitudinal welds per shell. For Successive Inspection Intervals, ASME Section XI requires only 1ft of one weld per head to be volumetrically examined.

5. Examination records for earlier Intervals could not be located in plant records during the preparation of this proposed alternative; however, recent examination data shows these welds have had acceptable results in accordance with Section XI.
6. Exelon has reviewed the missing coverages for the examinations in the First Interval and has concluded that the NDE code requirements and equipment for early interval examinations would not have resulted in an examination coverage lower than the minimum achieved coverage of 28.2%. In addition, there have been no design configuration changes that would alter examination access for any of the welds.

During Interval 3, the Calvert Cliffs, Units 1 and 2, pressurizer safety/relief nozzle welds 16-405A and 16-405B (for each unit) had a coverage of 36% (Unit 1) and 41% (Unit 2) (Note: The examinations performed during other Intervals for these welds have resulted in a coverage greater than 60%). Since the limited coverage was identified for the safety/relief nozzle welds, a review of the probability of leakage and rupture for various sensitivity studies from Reference [1] was done for leak paths PRNV-CE-4A/C, which is applicable to welds 16-405A and 16-405B as follows:

- Section 8.3.4.1.1 and Table 8-11 of Reference [1] discuss the probability of rupture and leakage for the case study where PSI-only was performed. The most limiting crack path for safety/relief nozzle welds (PRNV-CE-4A & PRNV-CE-4C), yielded a probability of leakage of $1.25x10^{-9}$ after 80 years and a probability of rupture of $1.25x10^{-9}$ after 80 years. The probability of leakage and the probability of rupture for this Case ID listed in Table 8-11 are approximately three orders of magnitude below the acceptance criteria utilized in Reference [1], Section 8.3.2.9, of 10^{-6} failures per year. Additionally, the impact of performing more examinations than the PSI-only case study, even with limited coverage, which was the case for welds 16-405A and 16-405B, would reduce the probability of rupture and leakage. Furthermore, as discussed in Section 8.3.4.1.1 of Reference [1], leakage of the pressure boundary is detectable by plant operators and plant procedures allow for safe plant shutdown under leaking conditions. Probabilities of rupture values are maintained well below the acceptance criterion for 80 years of operation even considering only PSI inspection. The examination results with coverage as low as 36% for welds 16-405A and 16-405B at Calvert Cliffs are bounded by the PSI-only sensitivity study in Reference [1] and the failure frequency for these welds would be below the NRC acceptance criteria of 10^{-6} failures per year.

- Section 8.3.5 and Table 8-33 of Reference [1] discuss the probability of leakage for the case study where only 50% coverage was achieved. For the leak path most applicable to welds 16-405A and 16-405B, PRNV-CE-4A/C were evaluated to have a probability of leakage of $1.25x10^{-9}$ after 80 years. There is a negligible change in the probability of leakage compared to the base case where 100% coverage was achieved. The sensitivity studies performed in Reference [1], including the Inspection Coverage case study, show that probabilities of rupture and leakage are not significantly affected by using a range of values for most of the input variables.

Also, during Interval 4 for Calvert Cliffs, Unit 1, and Interval 5 for Calvert Cliffs, Unit 2, pressurizer surge nozzle weld 4-404 had the minimum coverage of 31.8% and 28.2%, respectively. It should be noted that the prior examinations performed for these welds reported a coverage greater than 55%. Since the minimum coverage was identified for the surge line nozzle welds, a review of the probability of leakage and rupture for various sensitivity studies from Reference [1] was done for leak path PRNV-BW-1C, which is applicable to weld 4-404.

- Section 8.3.4.1.1 and Table 8-11 of Reference [1] discuss the probability of rupture and leakage for the case study where PSI-only was performed. The most limiting crack path for the surge line nozzle welds (PRNV-BW-1C), yielded a probability of leakage of 6.25×10^{-9} after 80 years and a probability of rupture of 1.25×10^{-9} after 80 years. The probability of leakage and the probability of rupture for this Case ID listed in Table 8-11 are approximately three orders of magnitude below the acceptance criteria utilized in Reference [1], Section 8.3.2.9, of 10^{-6} failures per year. Additionally, the impact of performing more examinations than the PSI-only case study, even with limited coverage, which was the case for weld 4-404, would reduce the probability of rupture and leakage; therefore, the examination results with coverage as low as 31.8% for weld 4-404 at Calvert Cliffs are bounded by the PSI-only case study in Reference [1] and the failure frequency for these welds would be below the NRC acceptance criteria of 10^{-6} failures per year.

- Section 8.3.5 and Table 8-33 of Reference [1] discuss the probability of leakage for the case study where only 50% coverage was achieved. For the leak path most applicable to weld 4-404, PRNV-BW-1C was evaluated to have a probability of leakage of 3.75×10^{-9} after 80 years. This was an increase of 2.5×10^{-9} compared to the base case where 100% coverage was achieved. This increase in the probability of leakage is small in comparison to the acceptance criteria of 10^{-6} failures per year. The sensitivity studies performed in Reference [1], including the Inspection Coverage case study, show that probabilities of rupture and leakage are not significantly affected by using a range of values for most of the input variables.

Considering all the findings from Reference [1] it can be concluded that the probability of failure is below 10^{-6} failures per year for welds 4-404, 16-405A, and 16-405B.

No flaws exceeding the ASME Section XI acceptance standards were identified during any prior examinations for Calvert Cliffs.

Conclusion

Based on the results of Reference [1] and its demonstrated applicability to Braidwood, Byron, and Calvert Cliffs, the subject pressurizer welds contained in this proposed alternative are very flaw tolerant. PFM and DFM evaluations performed as part of the technical basis in Reference [1] demonstrate that, after PSI, no other inspections are required for up to 60 years of operation to meet the NRC safety goal of 10^{-6} failures per reactor year. Plant-specific applicability of the technical basis to Braidwood, Byron, and Calvert Cliffs is demonstrated in Appendix A. While the technical bases demonstrate longer inspection intervals are possible, Exelon considers that deferral of these inspections until the end of the currently approved Period of Extended Operation (PEO), as shown in Table 1, is justified and provides an acceptable level of quality and safety in lieu of the current ASME Section XI 10-year inspection frequency.

The PWR fleet inspection history for the applicable components (obtained from an EPRI industry survey) is presented in Appendix B. The results of the survey indicate that these components are very flaw tolerant and prior instances of flaw detection are minimal.

Exelon operating and examination experience demonstrates that these welds have performed with very high reliability, mainly due to their robust designs and structural margins. As shown in the Tables 2 through 4, to-date, Exelon has performed nearly 200 inspections of the subject pressurizer welds at Braidwood, Byron, and Calvert Cliffs, with only one of these welds found to have recordable indications. The sizes of these indications have not increased since PSI. As indicated in the inspection history Tables 2 through 4, some of the examinations involved limited coverage of as low as 28.2%. However, due to the robust fabrication of these components and the intensive pre-service examinations performed, Reference [1] was able to conclude that performing only the PSI examination without any other follow-on ISI examinations is acceptable for up to 80 years of operation while still maintaining plant safety. In addition, it is important to note that all other inspection activities, including the ASME Section XI, Examination Category B-P system leakage test conducted during each refueling outage, will continue to be performed, providing further assurance of safety.

Finally, as discussed in Reference [2], for situations where no active degradation mechanism is present, it was concluded that subsequent inservice inspections do not provide additional value after the PSI has been performed. Braidwood, Byron, and Calvert Cliffs pressurizer welds have received the required PSI examinations along with nearly 200 subsequent inservice inspections with no service-induced indications documented.

Therefore, Exelon requests that the NRC authorize this proposed alternative in accordance with 10 CFR 50.55a(z)(1).

6 Duration of Proposed Alternative

The proposed alternative is requested for Braidwood, Byron, and Calvert Cliffs for the remainder of their currently approved operating license, currently scheduled to end on October 17, 2046 (Braidwood, Unit 1), December 18, 2047 (Braidwood, Unit 2), October 31, 2044 (Byron, Unit 1), November 6, 2046 (Byron, Unit 2), July 31, 2034 (Calvert Cliffs, Unit 1), and August 13, 2036 (Calvert Cliffs, Unit 2), as summarized in Table 1.

7 Precedent

To-date, one previous submittal has been made requesting relief from the ASME Code, Section XI, Examination Category B-B (Item Numbers B2.11 and B2.12) volumetric examinations on the basis of the Reference [1] Technical Report, as follows:

1. Letter from Paul R. Duke, Jr., Manager – Licensing, PSEG Nuclear LLC, to U.S. Nuclear Regulatory Commission Document Control Desk, "Proposed Alternative for Examination of ASME Section XI, Examination Category B-B, Item Number B2.11 and B2.12," August 5, 2020, ADAMS Accession No. ML20218A587.
2. Letter from Paul R. Duke, Jr., Manager – Licensing, PSEG Nuclear LLC, to U.S. Nuclear Regulatory Commission Document Control Desk, "Response to Request for Additional Information for Proposed Alternative for Examination of ASME Section XI, Examination Category B-B, Item Number B2.11 and B2.12," April 12, 2021, ADAMS Accession No. ML21102A024.

In addition, the following is a list of Proposed Alternatives and other precedents related to inspections of pressurizer welds and components:

- Letter from M. Lesniak (ComEd) to NRC, "Relief from Inservice Inspection Program Requirements for Pressurizer Surge Nozzle-to-Vessel Weld and Pressurizer Surge Nozzle Inner Radius Section," March 28, 1996, ADAMS Accession No. ML20101L096.
- Letter from R. Capra (NRC) to D. Farrar (Commonwealth Edison Company), "Safety Evaluation of Inservice Inspection Program Relief Request for Inspection of the Pressure Surge Nozzle-to-Vessel Weld; Byron and Braidwood Stations (TAC Nos. M95088, M95089, M95172, and M95173)," May 3, 1996, ADAMS Accession Nos. ML20108D006 and ML20108D016.
- Letter from M. G. Kowal (NRC) to M. A. Balduzi (Entergy Nuclear Operations, Inc.), "Indian Point Nuclear Generating Unit No. 2 – Relief Request No. RR-01 (TAC No. MD4695)," September 5, 2007, ADAMS Accession No. ML072130487.
- Letter from T. L. Tate (NRC) to Vice President, Operations (Entergy Nuclear Operations, Inc.), "Indian Point Nuclear Generating Unit No. 2 – Safety Evaluation for Relief Request No. IP2-ISI-RR-01, Examination of Upper Pressurizer Welds (CAC No. MF7082)," September 14, 2016, ADAMS Accession No. ML16179A178.
- Letter from N. DiFrancesco (NRC) to M. J. Pacilio (Exelon Generation Company, LLC), "Braidwood Station, Units 1 and 2 - Relief from the Requirements of the ASME Code for the Third 10-Year Interval of Inservice Inspection (TAC NOS. ME9748 AND ME9749)," January 30, 2013, ADAMS Accession No. ML13016A515.
- Letter from N. L. Salgado (NRC) to B. C. Hanson (Exelon Generation Company, LLC), "Braidwood Station, Units 1 and 2 – Relief from the Requirements of the ASME Code (EPID L-2019-LLR-0081)," May 14, 2020, ADAMS Accession No. ML20133K093.
- Letter from D. J. Wrona (NRC) to B. C. Hanson (Exelon Generation Company, LLC), "Byron Station, Units 1 and 2 - Request for Relief Nos. 13R-12 and 13R-15 from the Requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (CAC NOS. MF9884, MF9885, and MF9886; EPID NOS. 000976/05000454/L-2017-LLR-0055, 000976/05000455/L-2017-LLR-0055, AND 000976/05000455/L-2017-LLR-0056)," January 25, 2018, ADAMS Accession No. ML17349A960.

- Letter from J. G. Danna (NRC) to D. P. Rhoades (Exelon Generation Company, LLC), "Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Relief from the Requirements of the ASME Code Concerning Volumetric or Surface Examination Coverage for the Subject Welds (EPID L-2020-LLR-0089)," January 15, 2021, ADAMS Accession No. ML20356A121.

In addition, other studies have been performed by the industry to extend the inspection interval for various components and have been accepted by the NRC.

- Based on studies presented in Reference [11], the NRC approved extending the SG vessel and nozzle welds from 10 to 30 years for Vogtle in Reference [12].
- Based on studies presented in Reference [3], the NRC approved extending PWR reactor vessel nozzle-to-shell welds from 10 to 20 years in Reference [4].
- Based on work performed in BWRVIP-108, Reference [5], and BWRVIP-241, Reference [7], the NRC approved the reduction of BWR vessel nozzle-to-shell weld examinations (Item No. B3.90 for BWRs from 100% to a 25% sample of each nozzle type every 10 years) in References [6] and [8]. The work performed in BWRVIP-108 and BWRVIP-241 provided the technical basis for ASME Code Case N-702, Reference [9], which has been conditionally approved by the NRC in Revision 18 of Regulatory Guide 1.147, Reference [10].

8 <u>Acronyms</u>

ASME	American Society of Mechanical Engineers
B&W	Babcock and Wilcox
BWR	Boiling Water Reactor
BWRVIP	Boiling Water Reactor Vessel and Internals Program
CE	Combustion Engineering
CFR	Code of Federal Regulations
DFM	Deterministic fracture mechanics
EAF	Environmentally assisted fatigue
EPRI	Electric Power Research Institute
FAC	Flow accelerated corrosion
FEA	Finite element analysis
ISI	Inservice Inspection
MIC	Microbiologically influenced corrosion
NPS	Nominal pipe size
NRC	Nuclear Regulatory Commission
NSSS	Nuclear steam supply system
PFM	Probabilistic fracture mechanics
PWR	Pressurized Water Reactor
SCC	Stress corrosion cracking

9 REFERENCES:

1. *Technical Bases for Inspection Requirements for PWR Pressurizer Head, Shell-to- Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
2. American Society of Mechanical Engineers, Risk-Based Inspection: Development of Guidelines, Volume 2-Part 1 and Volume 2-Part 2, Light Water Reactor (LWR) Nuclear Power Plant Components. CRTD-Vols. 20-2 and 20-4, ASME Research Task Force on Risk-Based Inspection Guidelines, Washington, D.C., 1992 and 1998.
3. B. A. Bishop, C. Boggess, N. Palm, "Risk-Informed extension of the Reactor Vessel In-Service Inspection Interval," WCAP-16168-NP-A, Rev. 3, October 2011.
4. U.S. NRC, "Revised Final Safety Evaluation by the Office of Nuclear Reactor Regulation; Topical Report WCAP-16168-NP-A, Revision 2, 'Risk-Informed Extension of the Reactor Vessel In-service Inspection Interval,' Pressurized Water Reactor Owners Group, Project No. 694," July 26, 2011, ADAMS Accession No. ML111600303.
5. *BWRVIP-108: BWR Vessels and Internals Project, Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Shell Welds and Nozzle Blend Radii*, EPRI, Palo Alto, CA 2002. 1003557.
6. U.S. NRC, Safety Evaluation of Proprietary EPRI Report, "BWR Vessel and Internals Project, Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radius (BWRVIP-108)," December 19, 2007, ADAMS Accession No. ML073600374.
7. *BWRVIP-241: BWR Vessels and Internals Project, Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Shell Welds and Nozzle Blend Radii,* EPRI, Palo Alto, CA 2010. 1021005.
8. U.S. NRC, Safety Evaluation of Proprietary EPRI Report, "BWR Vessel and Internals Project, Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Shell Welds and Nozzle Blend Radii (BWRVIP-241)," April 19, 2013, ADAMS Accession Nos. ML13071A240 and ML13071A233.
9. Code Case N-702, "Alternate Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," ASME Code Section XI, Division 1, Approval Date: February 20, 2004.
10. U.S. NRC Regulatory Guide 1.147, Revision 19, "Inservice Inspection Code Case Acceptability, ASME Code Section XI, Division 1," October 2019.
11. *Technical Bases for Inspection Requirements for PWR Steam Generator Class 1 Nozzle-to-Vessel Welds and Class 1 and Class 2 Vessel Head, Shell, Tubesheet-to-Head and Tubesheet-to-Shell Welds*. EPRI, Palo Alto, CA: 2019. 3002015906.
12. U.S. NRC, "Vogtle Electric Generating Plant, Units 1 and 2 - Relief Request for Proposed Inservice Inspection Alternative VEGP-ISI-ALT-04-04 to the Requirements of the ASME Code (EPID L-2020-LLR-0109)," January 11, 2021, ADAMS Accession No. ML20352A155.
13. American Society of Mechanical Engineers, Section XI "Rules for Inservice Inspection of Nuclear Power Plant Components", 2007 Edition with 2008 Addenda, 2013 Edition, and 2019 Edition.
14. U.S. NRC, "Vogtle Electric Generating Plant, Units 1 and 2 - Audit Report for the Promise Version 1.0 Probabilistic Fracture Mechanics Software Used in Relief Request VEGP-ISI-ALT-04-04 (EPID L-2019-LLR-0109)," December 10, 2020, ADAMS Accession No. ML20258A002.
15. U.S. NRC Regulatory Federal Register Volume 86, Issue 57, March 26, 2021.

APPENDIX A

Plant-Specific Applicability

Plant-Specific Applicability for Braidwood Station

Section 9 of Reference [A1] provides applicability requirements that must be demonstrated in order to apply the representative stress and flaw tolerance analyses to a specific plant. Plant-specific evaluation of these requirements for Braidwood is provided in Table A-1.

Table A-1 indicates that all plant-specific requirements are met for Braidwood. Therefore, the results and conclusions of the EPRI report are applicable to Braidwood.

Table A-1
Plant-Specific Applicability of Reference [A1] Representative Analyses to Braidwood Station, Units 1 and 2
Pressurizer Shell-to-Head Welds (Circumferential and Longitudinal) and Nozzle-to-Shell Welds
(Item Numbers B2.11, B2.12, and B3.110)

Category	Requirement from Reference [A1]	Applicability to Braidwood Station, Units 1 and 2
General Requirements	The plant-specific pressurizer general transients and cycles must be bounded by those shown in Table 5-6 for a 60- year operating life. It should be noted that the number of cycles were extrapolated to 80 years in the evaluations.	In Appendix C of this proposed alternative, the number and type of the Braidwood, Units 1 and 2 general transients are compared to the transients listed in Table 5-6 of Reference [A1]. As shown in Table C-2, the Braidwood, Units 1 and 2 transients are bounded by the transients listed in Table 5-6 of Reference [A1].

Category	Requirement from Reference [A1]	Applicability to Braidwood Station, Units 1 and 2
	The materials of the pressurizer shell and nozzles must be low alloy ferritic steels which conform to the requirements of ASME Code, Section XI, Appendix G, Paragraph G-2110.	The Braidwood, Units 1 and 2, pressurizer upper and lower heads are fabricated of SA-533 Grade A, Class 2, to meet ASME Nuclear Vessels Code Section III. SA-533 Grade A, Class 2 material is not specifically listed in ASME Code, Section XI, Appendix G. However, SA-533 Grade A, Class 2 material has similar toughness and chemical composition to SA-533, Grade B, Class 1, SA-508-1, SA-508-2, and SA-508-3. SA-533 Grade A, Class 2 has a specified minimum yield strength at room temperature of 70 ksi (which is greater than 50 ksi), and the maximum RT_{NDT} values for the Braidwood pressurizer bottom head materials are 60°F or less (so the RT_{NDT} of 60°F used in the EPRI report is bounding). Appendix G, Table G-2110-1, of the 2019 Edition of ASME Section XI acknowledges that Figure G-2210-1 is applicable to material SA-533 Grade A, Class 2. Therefore, it can be concluded that the EPRI report is applicable to material SA-533 Grade A, Class 2. Also, material properties in SA-533 Grade A, Class 2 material are identical compared to the SA-533 Grade B Class 1 material used in the FEA in the EPRI report as is shown Table 5-2 of Reference [A1]. Therefore, by comparison, SA-533 Grade A, Class 2 material is consistent with the requirements of ASME Code, Section XI, Appendix G and satisfies the requirements for application of the EPRI report. The Braidwood, Units 1 and 2, pressurizer shells are fabricated from SA-533 Grade A, Class 2, material. The Braidwood, Units 1 and 2, pressurizer Surge, Spray, and Safety-Relief valve nozzles are all fabricated from SA-508, Class 2, material. The materials for the pressurizer shells conform to the requirements of ASME Code, Section XI, Appendix G, Paragraph G-2110.

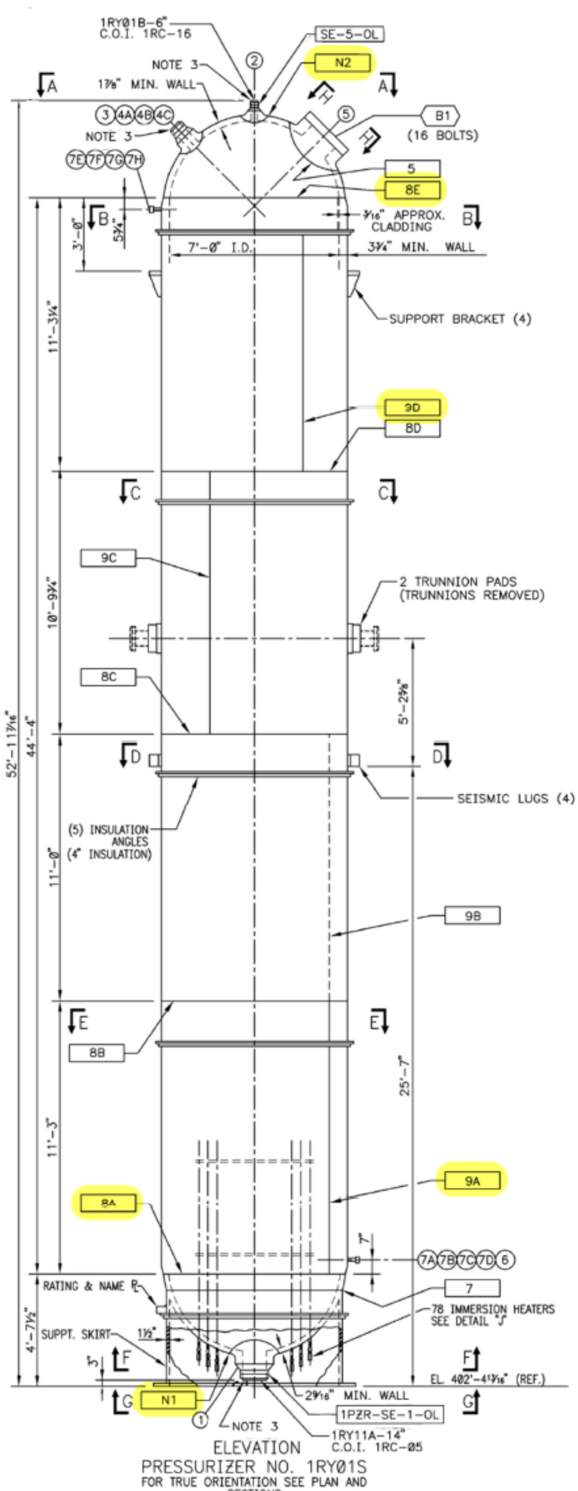
Category	Requirement from Reference [A1]	Applicability to Braidwood Station, Units 1 and 2
Specific Requirements	The plant-specific pressurizer surge nozzle and bottom head weld configurations must conform to those shown in Figure 1-1 (Item No. B2.11), Figure 1-2 (Item No. B2.12) and Figures 1-4 and 1-5 (Item No. B3.110) of Reference [A1].	The Braidwood, Units 1 and 2, pressurizer shell-to-head and nozzle-to-vessel weld configurations included in this request are shown in Figures A-1, A-2, A-3, and A-4 and show conformance with the figures shown in Reference [A1].
	The plant-specific dimensions of the pressurizer shell and the surge nozzle must be within the range of values listed in Table 9-1 of Reference [A1].	The comparison of the Braidwood, Units 1 and 2, pressurizer shell dimensions with those in Table 9-1 of Reference [A1] is provided in Table A-2. The comparison shows that the Braidwood, Units 1 and 2 configurations are within the range of values shown in Table 9-1 of Reference [A1].
	The plant-specific Insurge/Outsurge transient definitions (temperature difference between the pressurizer shell and the pressurizer surge nozzle fluid temperature and associated number of cycles) must be bounded by those shown in Table 5-10 for a Westinghouse/CE plant of Reference [A1].	In Appendix D of this proposed alternative, the Braidwood, Units 1 and 2, Insurge/Outsurge transients are compared to the number and type of transients listed in Table 5-10 of Reference [A1]. As can be seen from Table D-2, the Braidwood, Units 1 and 2, transients are bounded by those transients listed in Table 5-10 of Reference [A1].

Table A-2
Range of Geometric Parameters for which the Evaluation is Applicable in Comparison with Braidwood Station, Units 1 and 2

Component	Geometric Parameter	For a Westinghouse Plant	Braidwood Station, Units 1 and 2 Dimensions
Pressurizer Shell	Inside Diameter (in)	Must be between 80 and 88	84 [A3]
Surge Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 12 and 18	14 [A2]
Safety/Relief Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 4 and 8	6 [A2]
Spray Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 4 and 6	4 [A2]

REFERENCES

A1. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to- Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
A2. Westinghouse Electric Corporation Drawing No. 1100J48, *Outline: Pressurizer 1800 Cu. Ft. [50.96].*
A3. Westinghouse Electric Corporation Drawing No. 1101J22, *General Arrangement: Pressurizer 1800 Cu. Ft. [50.96].*
A4. Braidwood Station, Drawings 1PZR-01 and 2PZR-01, *Inspection Identification Drawing Inservice Inspection for Pressurizer NC. 1RY01S and 2RY01S*.



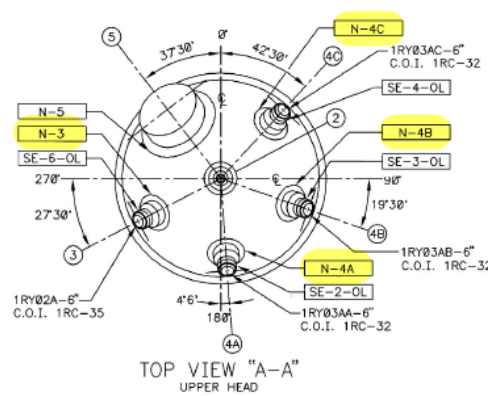


Figure A-1: Braidwood Station, Unit 1 Pressurizer Vessel Weld Locations [A4]

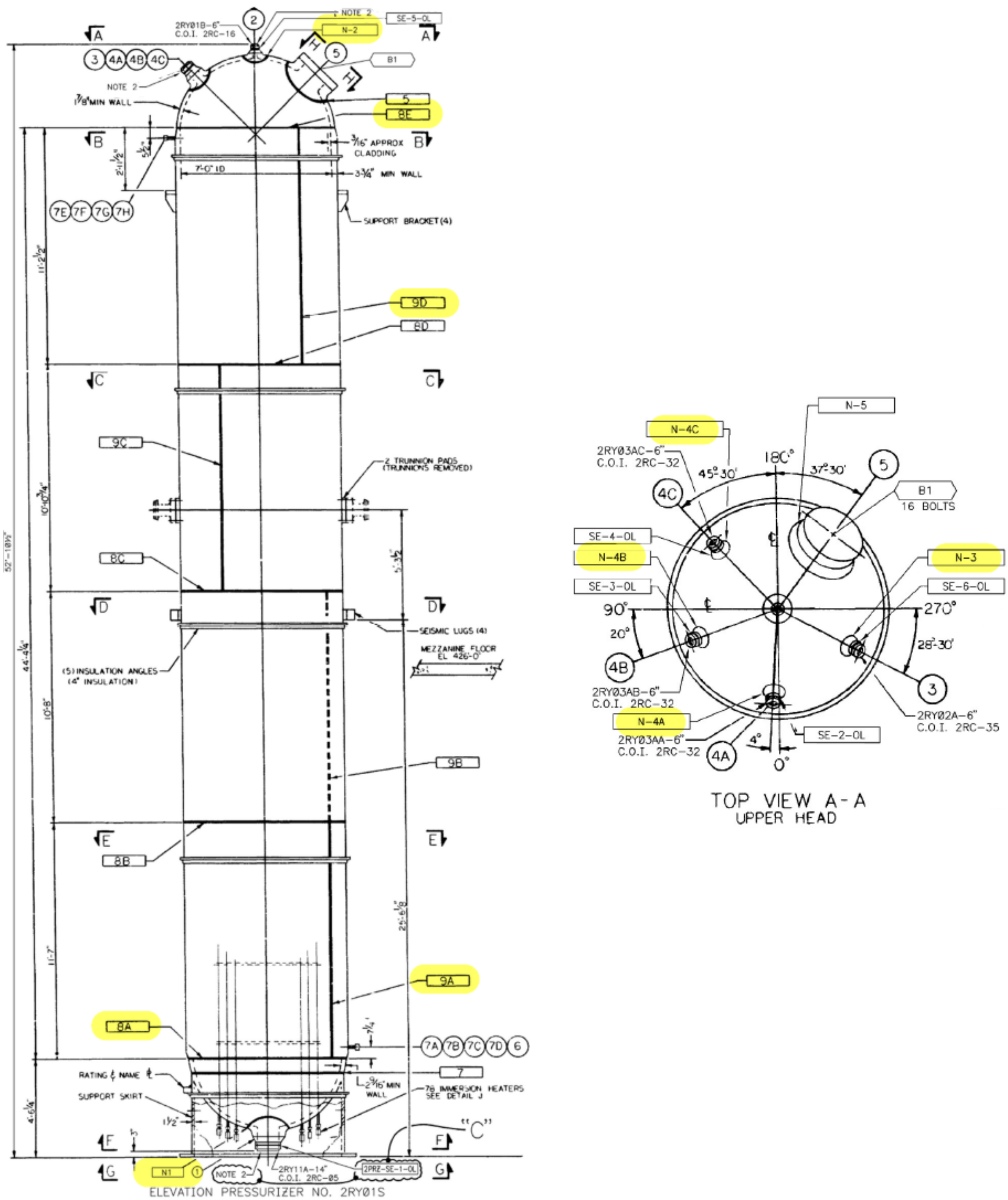


Figure A-2: Braidwood Station, Unit 2 Pressurizer Vessel Weld Locations [A4]

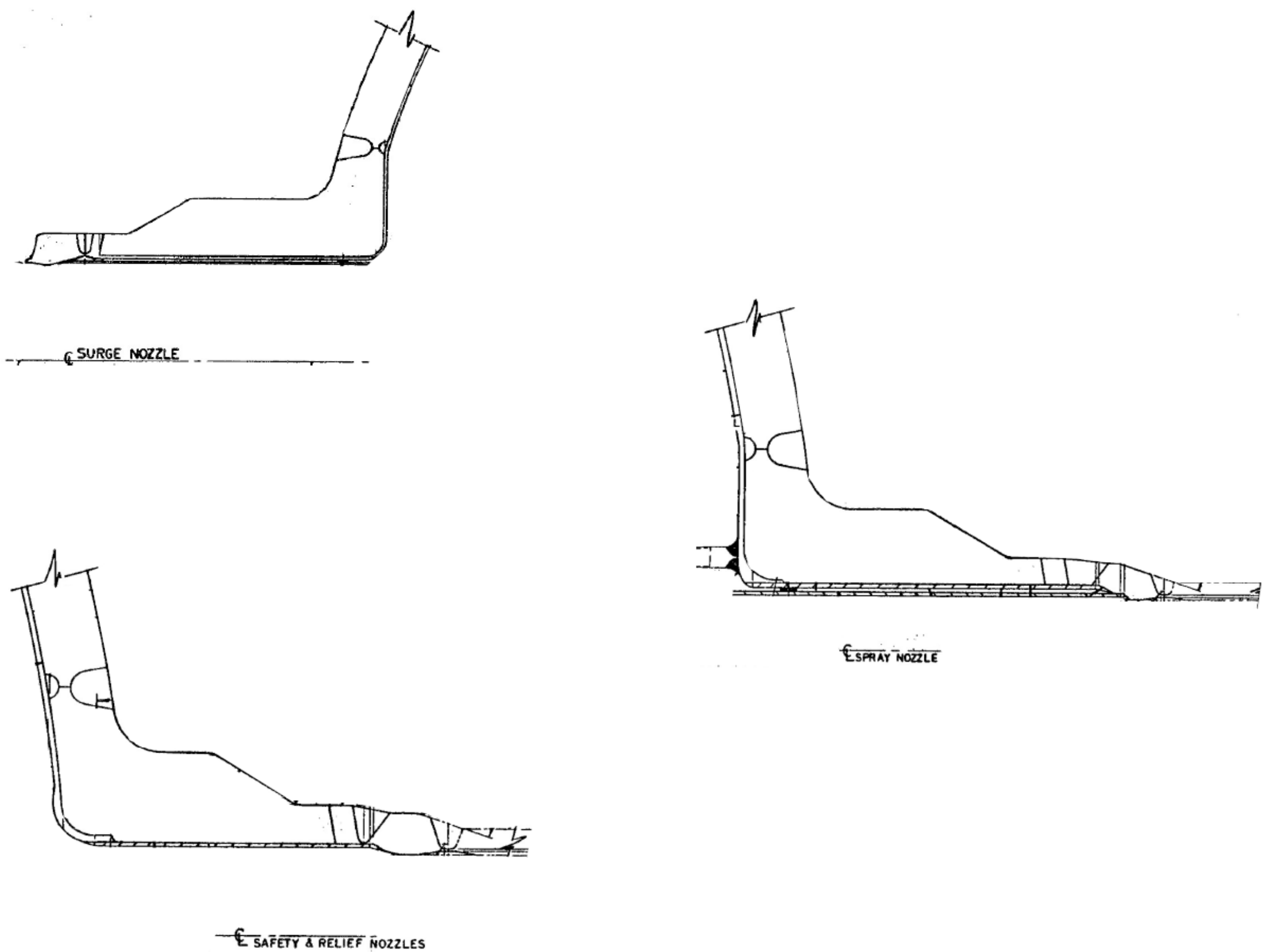
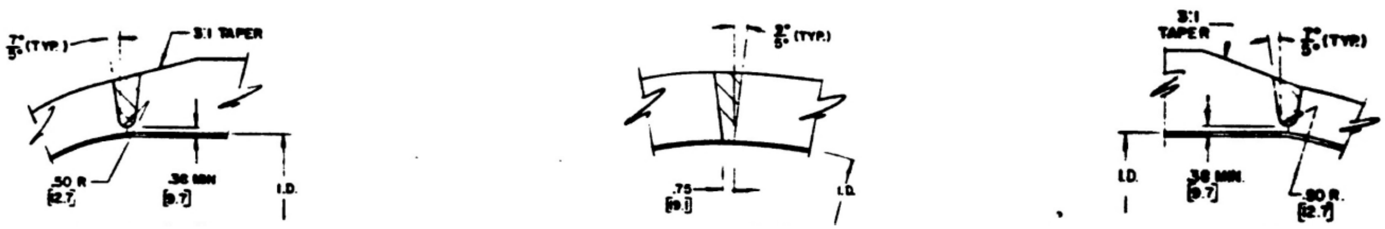


Figure A-3: Braidwood Station, Units 1 and 2 Typical Pressurizer Nozzle-to-Shell Weld Details



Lower Head to Shell Weld Detail

Shell Longitudinal Weld Detail

Upper Head to Shell Weld Detail

Figure A-4: Braidwood Station, Units 1 and 2 Typical Shell and Head Weld Details [A3]

Plant-Specific Applicability for Byron Station

Section 9 of Reference [A5] provides applicability requirements that must be demonstrated in order to apply the representative stress and flaw tolerance analyses to a specific plant. Plant-specific evaluation of these requirements for Byron is provided in Table A-3.

Table A-3 indicates that all plant-specific requirements are met for Byron. Therefore, the results and conclusions of the EPRI report are applicable Byron.

Table A-3
Plant-Specific Applicability of Reference [A5] Representative Analyses to Byron Station, Units 1 and 2
Pressurizer Shell-to-Head Welds (Circumferential and Longitudinal) and Nozzle-to-Shell Welds
(Item Numbers B2.11, B2.12, and B3.110)

Category	Requirement from Reference [A5]	Applicability to Byron Station, Units 1 and 2
General Requirements	The plant-specific pressurizer general transients and cycles must be bounded by those shown in Table 5-6 for a 60- year operating life. It should be noted that the number of cycles were extrapolated to 80 years in the evaluations.	In Appendix C of this proposed alternative, the number and type of the Byron, Units 1 and 2 general transients are compared to the transients listed in Table 5-6 of Reference [A5]. As shown in Table C-4, the Byron, Units 1 and 2 transients are bounded by the transients listed in Table 5-6 of Reference [A5].

Category	Requirement from Reference [A5]	Applicability to Byron Station, Units 1 and 2
	The materials of the pressurizer shell and nozzles must be low alloy ferritic steels which conform to the requirements of ASME Code, Section XI, Appendix G, Paragraph G-2110.	The Byron, Units 1 and 2, pressurizer upper and lower heads are fabricated of carbon steel casting SA-533 Grade A, Class 2, to meet ASME Nuclear Vessels Code Section III. SA-533 Grade A, Class 2 material is not specifically listed in ASME Code, Section XI, Appendix G. However, SA-533 Grade A, Class 2 material has similar toughness and chemical composition to SA-533, Grade B, Class 1, SA-508-1, SA-508-2, and SA-508-3. SA-533 Grade A, Class 2 has a specified minimum yield strength at room temperature of 70 ksi (which is greater than 50 ksi), and the maximum RT_{NDT} values for the Byron pressurizer bottom head materials are 60°F or less (so the RT_{NDT} of 60°F used in the EPRI report is bounding). Appendix G, Table G-2110-1, of the 2019 Edition of ASME Section XI acknowledges that Figure G-2210-1 is applicable to material SA-533 Grade A, Class 2. Therefore, it can be concluded that the EPRI report is applicable to material SA-533 Grade A, Class 2. Also, material properties in SA-533 Grade A, Class 2 material is identical compared to the SA-533 Grade B Class 1 material used in the FEA in the EPRI report as is shown Table 5-2 of Reference [A5]. Therefore, by comparison, SA-533 Grade A, Class 2 material is consistent with the requirements of ASME Code, Section XI, Appendix G and satisfies the requirements for application of the EPRI report. The Byron, Units 1 and 2, pressurizer shells are fabricated from SA-533 Grade A, Class 2, material. The Byron, Units 1 and 2 pressurizer Surge, Spray, and Safety-Relief valve nozzles are all fabricated from SA-508, Class 2, material. The materials for the pressurizer shells conform to the requirements of ASME Code, Section XI, Appendix G, Paragraph G-2110.

Category	Requirement from Reference [A5]	Applicability to Byron Station, Units 1 and 2
Specific Requirements	The plant-specific pressurizer surge nozzle and bottom head weld configurations must conform to those shown in Figure 1-1 (Item No. B2.11), Figure 1-2 (Item No. B2.12) and Figures 1-4 and 1-5 (Item No. B3.110) of Reference [A5].	The Byron, Units 1 and 2, pressurizer shell-to-head and nozzle-to-vessel weld configurations included in this request are shown in Figures A-5, A-6, A-7, and A-8 and show conformance with the figures shown in Reference [A5].
	The plant-specific dimensions of the pressurizer shell and the surge nozzle must be within the range of values listed in Table 9-1 of Reference [A5].	The comparison of the Byron, Units 1 and 2, pressurizer shell dimensions with those in Table 9-1 of Reference [A5] is provided in Table A-4. The comparison shows that the Byron, Units 1 and 2, configurations are within the range of values shown in Table 9-1 of Reference [A5].
	The plant-specific Insurge/Outsurge transient definitions (temperature difference between the pressurizer shell and the pressurizer surge nozzle fluid temperature and associated number of cycles) must be bounded by those shown in Table 5-10 for a Westinghouse/CE plant of Reference [A5].	In Appendix D of this proposed alternative, the Byron, Units 1 and 2, Insurge/Outsurge transients are compared to the number and type of transients listed in Table 5-10 of Reference [A5]. As can be seen from Table D-4, the Byron, Units 1 and 2, transients are bounded by those transients listed in Table 5-10 of Reference [A5].

Table A-4
Range of Geometric Parameters for which the Evaluation is Applicable in Comparison with Byron Station, Units 1 and 2

Component	Geometric Parameter	For a Westinghouse Plant	Byron Station, Units 1 and 2 Dimensions
Pressurizer Shell	Inside Diameter (in)	Must be between 80 and 88	84 [A7]
Surge Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 12 and 18	14 [A6]
Safety/Relief Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 4 and 8	6 [A6]
Spray Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 4 and 6	4 [A6]

REFERENCES

A5. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to- Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
A6. Westinghouse Electric Corporation Drawing No. 1100J48, *Outline: Pressurizer 1800 Cu. Ft. [50.96].*
A7. Westinghouse Electric Corporation Drawing No. 1101J22, *General Arrangement: Pressurizer 1800 Cu. Ft. [50.96].*
A8. Byron Station, Drawings 1PZR-1-ISI and 2PZR-1-ISI, *Inspection Identification Drawing Inservice Inspection for Pressurizer No. 1RY01S and 2RY01S*.

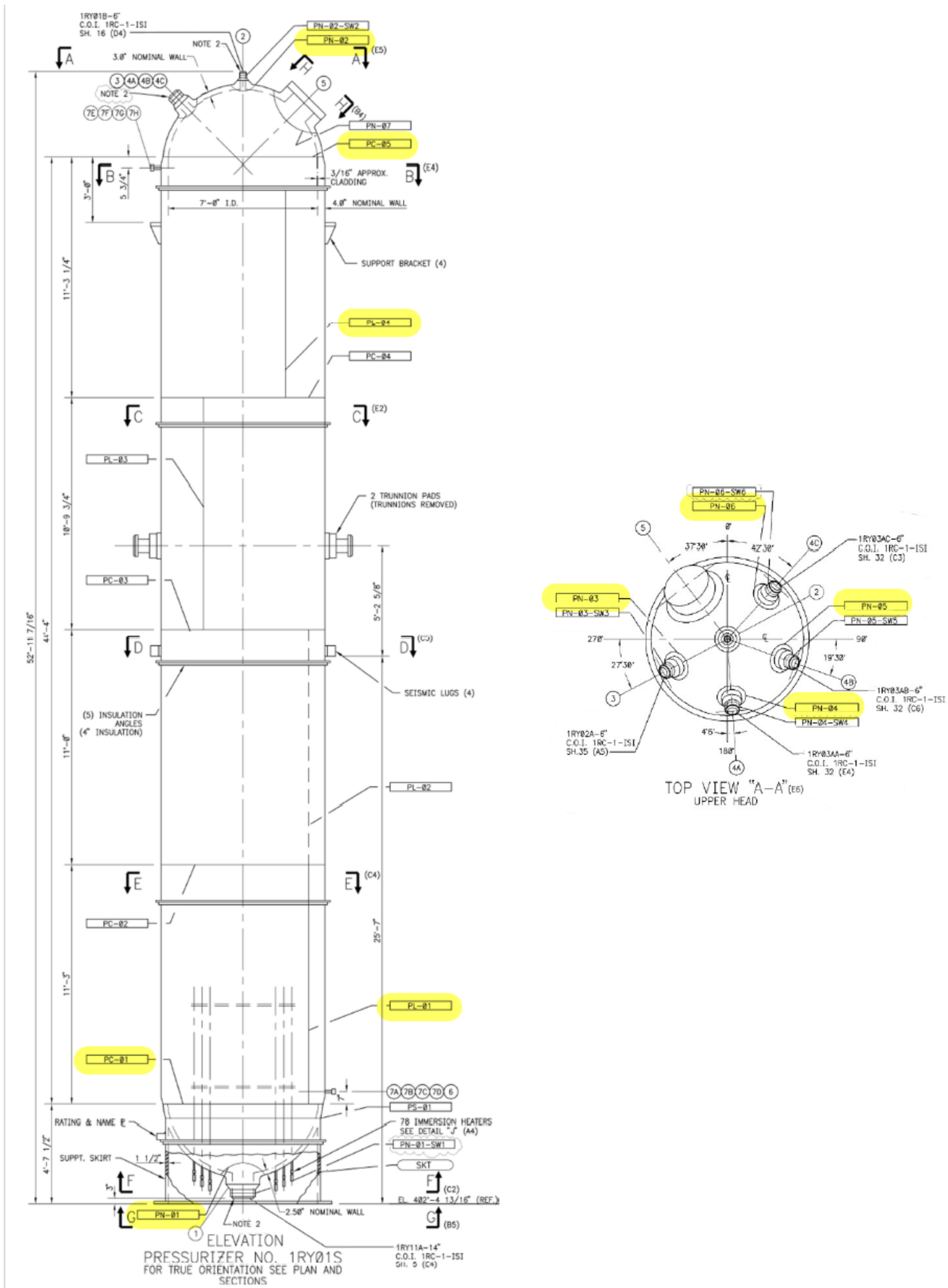


Figure A-5: Byron Station, Unit 1 Pressurizer Vessel Weld Locations [A8]

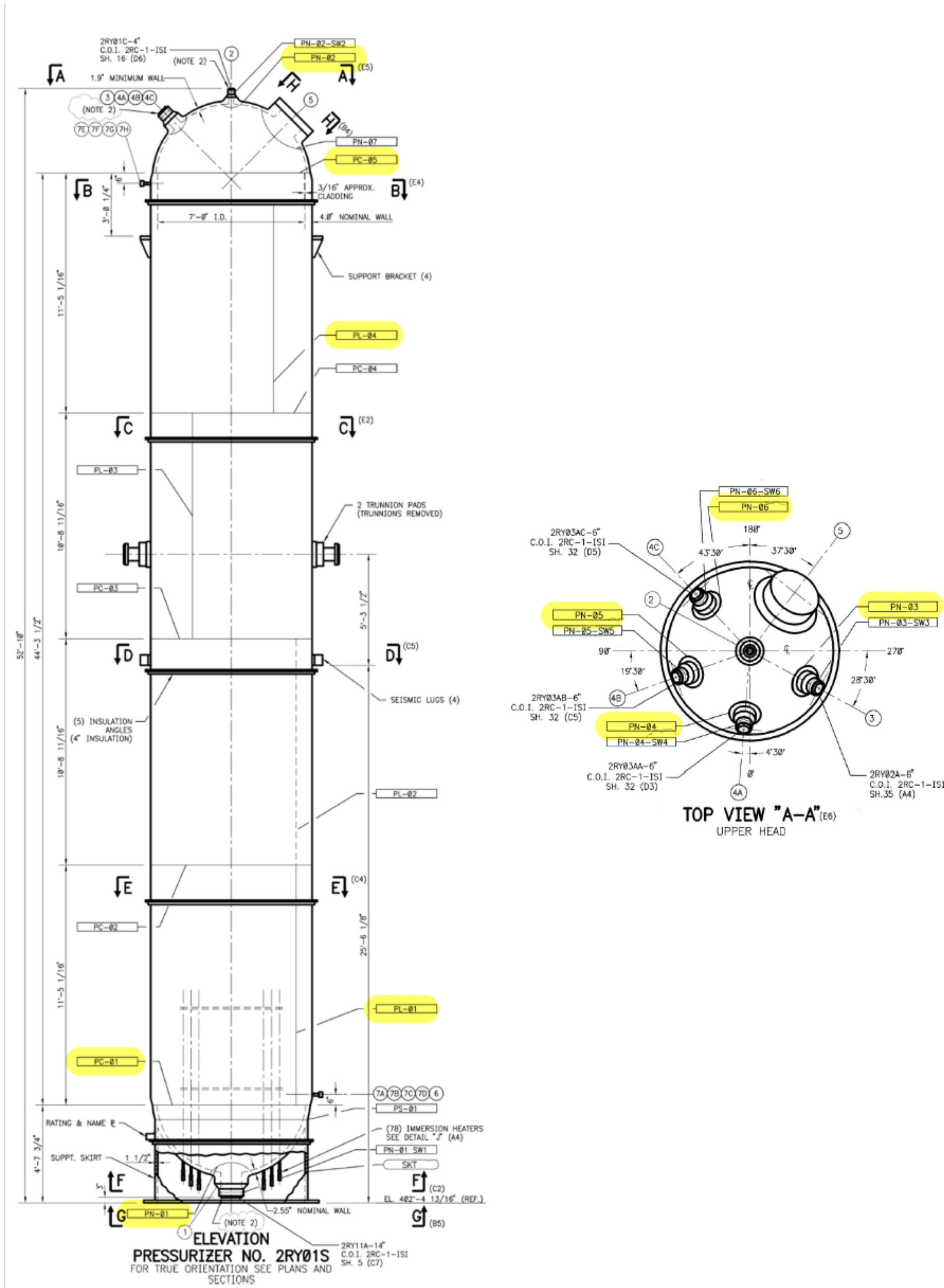


Figure A-6: Byron Station, Unit 2 Pressurizer Vessel Weld Locations [A8]

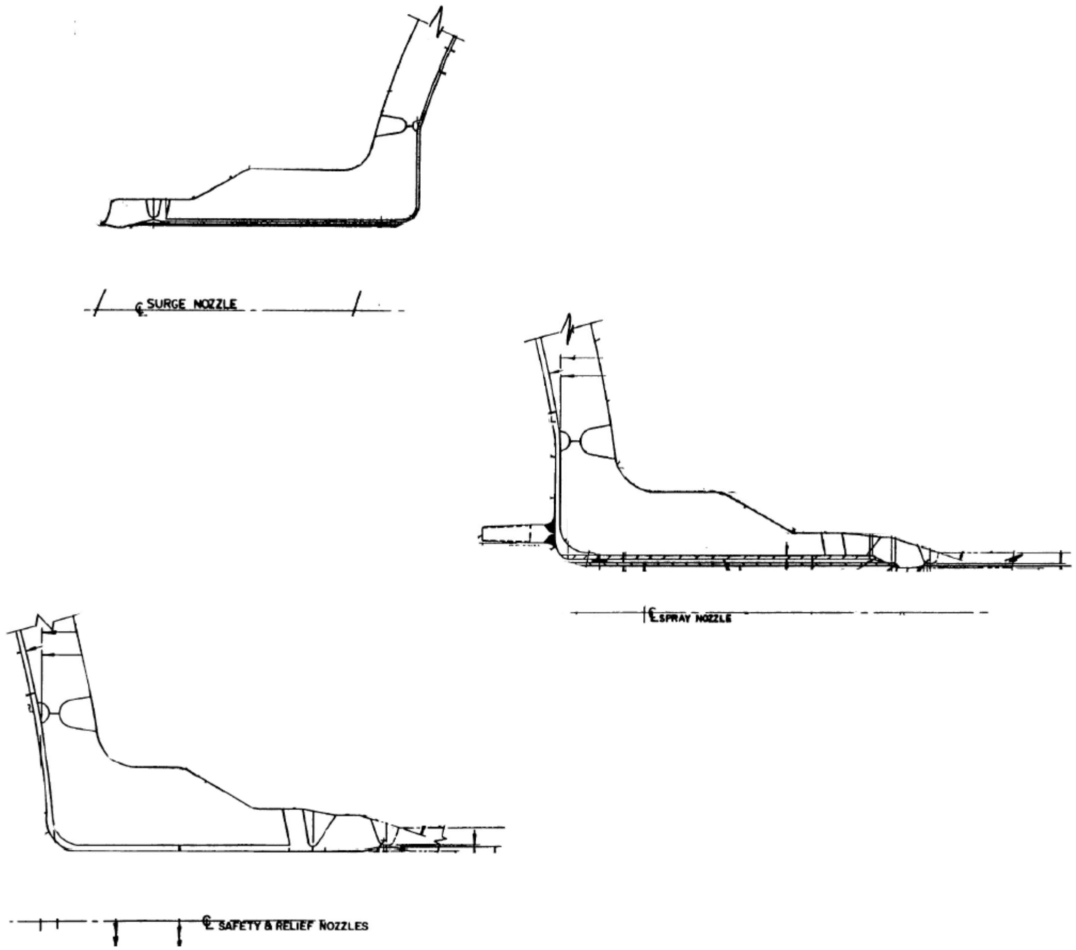
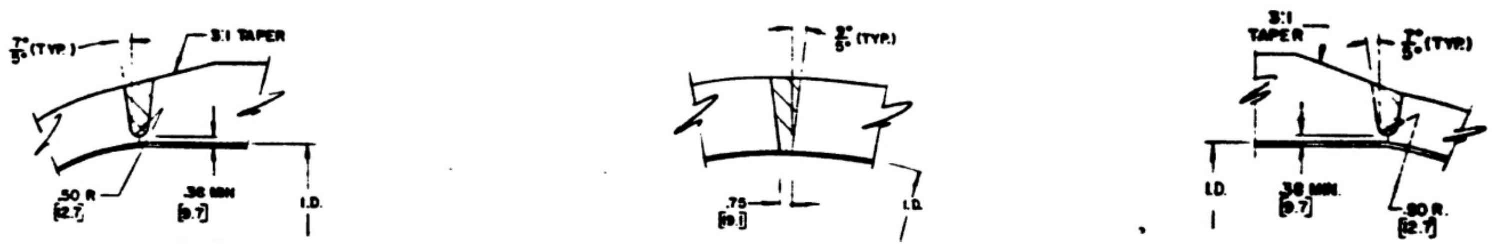


Figure A-7: Byron Station, Units 1 and 2 Typical Pressurizer Nozzle-to-Shell Weld Details



Lower Head to Shell
Weld Detail

Shell Longitudinal
Weld Detail

Upper Head to Shell
Weld Detail

Figure A-8: Byron Station, Units 1 and 2 Typical Shell and Head Weld Details [A5]

Plant-Specific Applicability for Calvert Cliffs

Section 9 of Reference [A9] provides applicability requirements that must be demonstrated in order to apply the representative stress and flaw tolerance analyses to a specific plant. Plant-specific evaluation of these requirements for Calvert Cliffs, Units 1 and 2 is provided in Table A-5.

Table A-5 indicates that all plant-specific requirements are met for Calvert Cliffs, Units 1 and 2. Therefore, the results and conclusions of the EPRI report are applicable to Calvert Cliffs, Units 1 and 2.

Table A-5
Plant-Specific Applicability of Reference [A9] Representative Analyses to Calvert Cliffs Nuclear Power Plant, Units 1 and 2
Pressurizer Shell-to-Head Welds (Circumferential and Longitudinal) and Nozzle-to-Shell Welds
(Item Numbers B2.11, B2.12, and B3.110)

Category	Requirement from Reference [A9]	Applicability to Calvert Cliffs, Units 1 and 2
General Requirements	The plant-specific pressurizer general transients and cycles must be bounded by those shown in Table 5-6 for a 60- year operating life. It should be noted that the number of cycles were extrapolated to 80 years in the evaluations.	In Appendix C of this proposed alternative, the number and type of the Calvert Cliffs, Units 1 and 2, general transients are compared to the transients listed in Table 5-6 of Reference [A9]. As shown in Table C-6, the Calvert Cliffs, Units 1 and 2, transients are bounded by the transients listed in Table 5-6 of Reference [A9].

Category	Requirement from Reference [A9]	Applicability to Calvert Cliffs, Units 1 and 2
	The materials of the pressurizer shell and nozzles must be low alloy ferritic steels which conform to the requirements of ASME Code, Section XI, Appendix G, Paragraph G-2110.	The Calvert Cliffs, Units 1 and 2, pressurizer upper and lower heads are fabricated of SA-533, Grade B, Class 1, to meet ASME Nuclear Vessels Code Section III. SA-533, Grade B, Class 1 material is specifically listed in ASME Code, Section XI, Appendix G. SA-533, Grade B, Class 1 has a specified minimum yield strength at room temperature of 50 ksi, and the RT_{NDT} values for the Calvert Cliffs, Units 1 and 2, pressurizer top head materials are not greater than 60°F (so the RT_{NDT} of 60°F used in the EPRI report is bounding). Also, material properties in SA-533, Grade B, Class 1 material are identical to the material used in the FEA in the EPRI report. Therefore, by comparison, SA-533, Grade B, Class 1 material is consistent with the requirements of ASME Code, Section XI, Appendix G and satisfies the requirements for application of the EPRI report. The Calvert Cliffs, Units 1 and 2, pressurizer shells are fabricated from SA-533, Grade B, Class 1, material. The Calvert Cliffs, Units 1 and 2, pressurizer Surge, Spray, and Safety-Relief valve nozzles are all fabricated from A-508, Class 2, material. The materials for the pressurizer shells conform to the requirements of ASME Code, Section XI, Appendix G, Paragraph G-2110.
Specific Requirements	The plant-specific pressurizer surge nozzle and bottom head weld configurations must conform to those shown in Figure 1-1 (Item No. B2.11), Figure 1-2 (Item No. B2.12) and Figures 1-4 and 1-5 (Item No. B3.110) of Reference [A9].	The Calvert Cliffs Units 1 and 2 pressurizer shell-to-head and nozzle-to-vessel weld configurations included in this request are shown in Figures A-9, A-10, A-11, and A-12 and show conformance with the figures shown in Reference [A9].
	The plant-specific dimensions of the pressurizer shell and the surge nozzle must be within the range of values listed in Table 9-1 of Reference [A9].	The comparison of the Calvert Cliffs Units 1 and 2 pressurizer shell dimensions with those in Table 9-1 of Reference [A9] is provided in Table A-6. The comparison shows that the Calvert Cliffs Units 1 and 2 configurations are within the range of values shown in Table 9-1 of Reference [A9].

Category	Requirement from Reference [A9]	Applicability to Calvert Cliffs, Units 1 and 2
	The plant-specific Insurge/Outsurge transient definitions (temperature difference between the pressurizer shell and the pressurizer surge nozzle fluid temperature and associated number of cycles) must be bounded by those shown in Table 5-10 for a Westinghouse/CE plant of Reference [A9].	Calvert Cliffs does not track individual thermal transients as it is presented in the EPRI Report. Therefore, in Appendix D of this proposed alternative, the Calvert Cliffs Units 1 and 2 stress-based fatigue monitoring values (U and UEN) were projected out to the current end-of-license operating period (60 years) and are compared to the design limit value of 1.0 as shown in Tables D-5 and D-6. As can be seen from Table D-6, the Calvert Cliffs Units 1 and 2 fatigue values are well below the design limits and are satisfactory through 60 years of operation.

Table A-6
Range of Geometric Parameters for which the Evaluation is Applicable in Comparison with Calvert Cliffs, Units 1 and 2

Component	Geometric Parameter	For a CE Plant	Calvert Cliffs Units 1 and 2 Dimensions
Pressurizer Shell	Inside Diameter (in)	Must be between 90 and 102	96 [A10]
Surge Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 10 and 14	12 [A11]
Safety/Relief Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 4 and 6	4 [A12]
Spray Nozzle	NPS of piping or component (e.g., reducer) attached to nozzle safe-end (in)	Must be between 4 and 6	4 [A12]

REFERENCES

A9. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to- Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
A10. Calvert Cliffs, Units 1 and 2, Drawing 12019-0005, *96" I.D. Pressurizer.*
A11. Calvert Cliffs, Units 1 and 2, Drawing 12019-0010, *Nozzle Details 96" I.D. Pressurizer.*
A12. Calvert Cliffs, Units 1 and 2, Drawing 12019-0012, *Nozzle Details 96" I.D. Pressurizer.*
A13. Calvert Cliffs, Units 1 and 2, ISI Figure A-3.

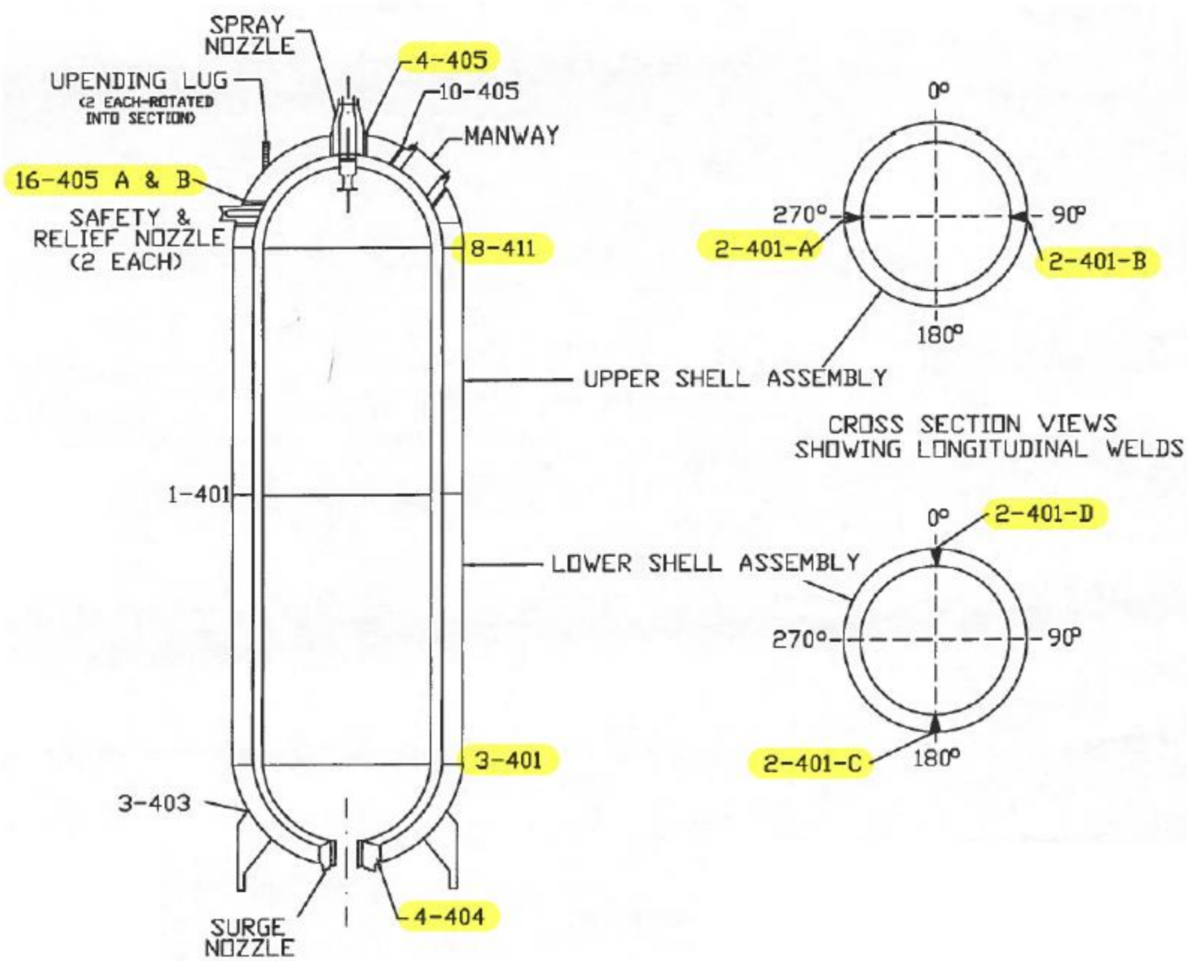


Figure A-9: Calvert Cliffs, Unit 1 Pressurizer Vessel Weld Locations [A13]

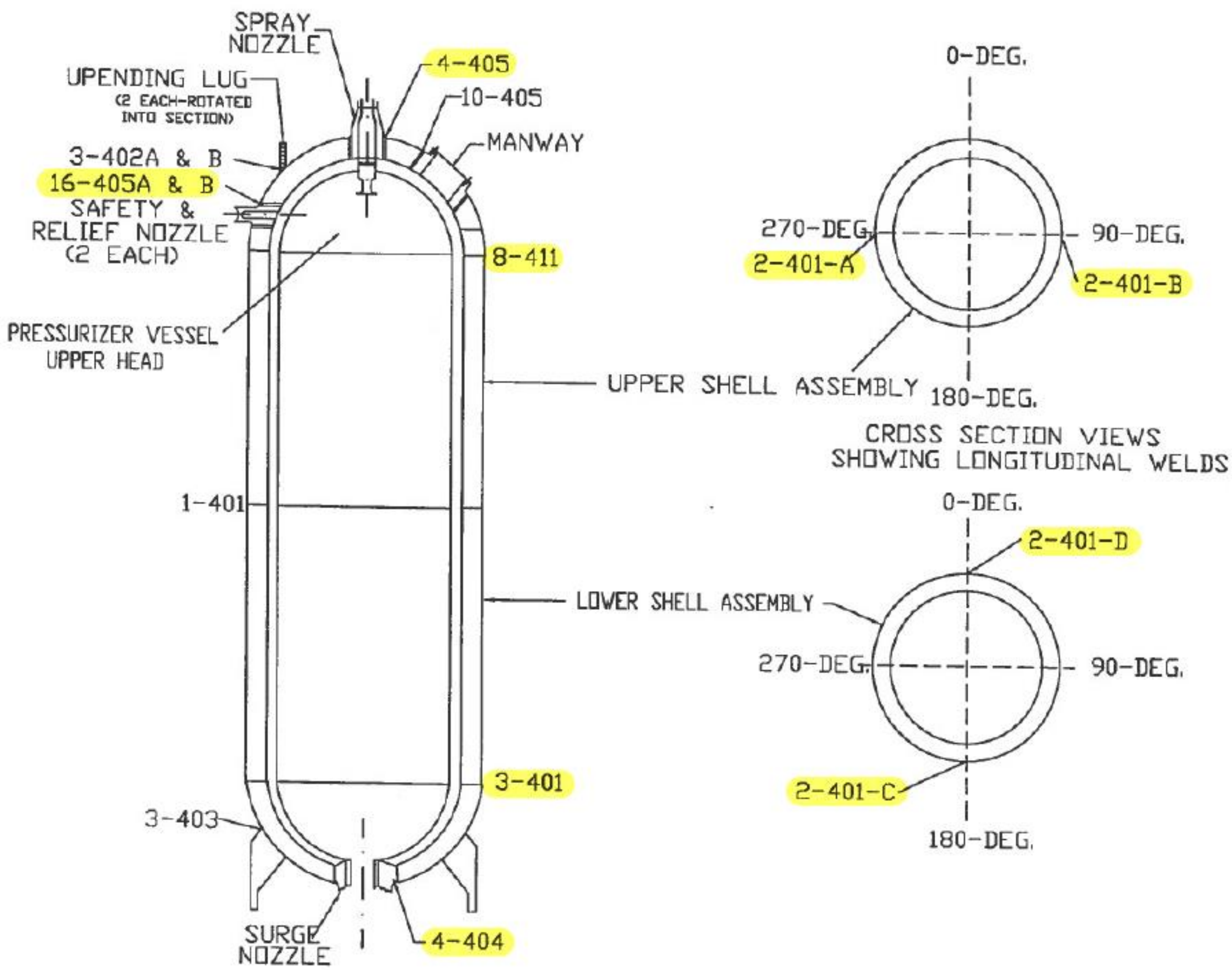
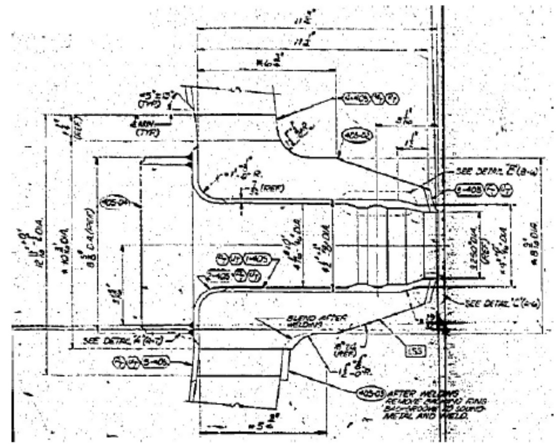
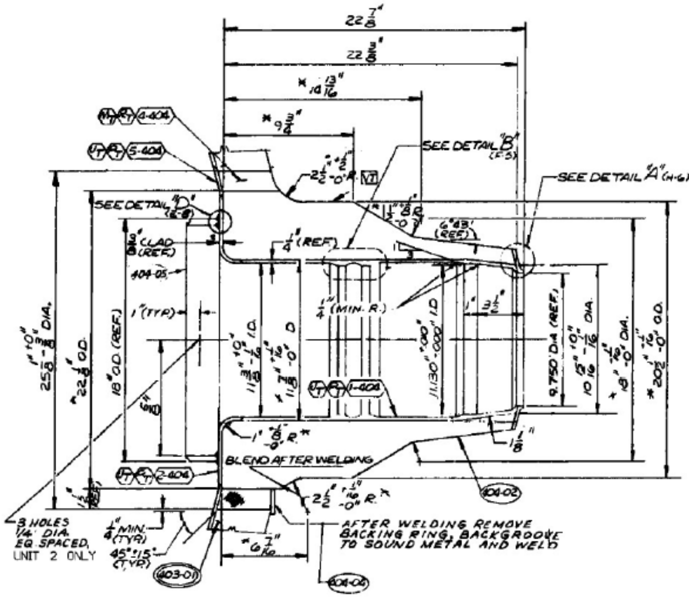


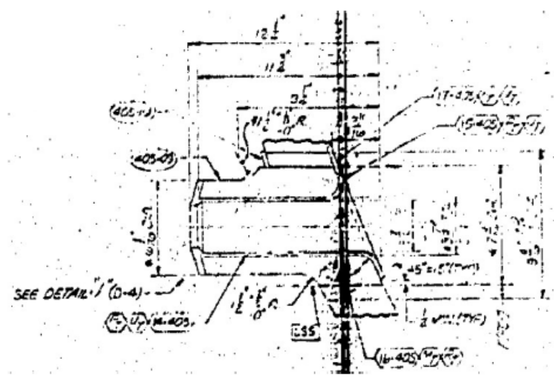
Figure A-10: Calvert Cliffs, Unit 2 Pressurizer Vessel Weld Locations [A13]



Spray Nozzle

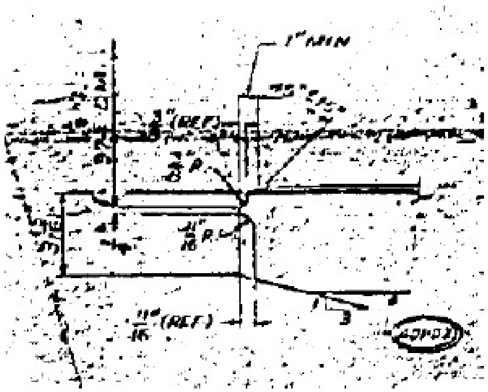


Surge Nozzle

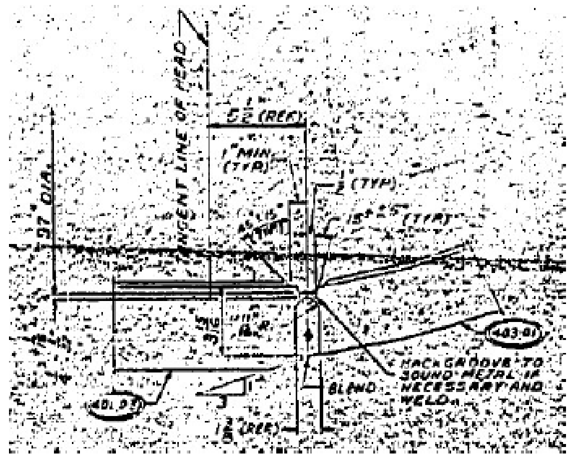


Safety & Relief Nozzle

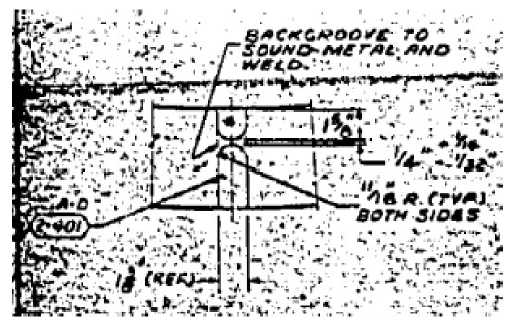
Figure A-11: Calvert Cliffs, Units 1 and 2 Typical Pressurizer Nozzle-to-Shell Weld Details [A11 & A12]



Upper Head to Shell
Weld Detail



Lower Head to Shell
Weld Detail



Shell Longitudinal
Weld Detail

Figure A-12: Calvert Cliffs, Units 1 and 2 Typical Pressurizer Vessel Shell Weld Details [A10]

APPENDIX B

Results of Industry Survey

Overall Industry Inspection Summary

The results of an industry survey of past inspections of pressurizer welds are summarized in Reference [B1]. Table B-1 provides a summary of the combined survey results for Item Numbers B2.11, B2.12, and B3.110. The results identify that pressurizer examination of the items adversely impact outage activities including worker exposure, personnel safety, and radwaste. A total of 47 domestic and international PWR units responded to the survey and provided information representing all PWR plant designs currently in operation in the U.S. This included 2-loop, 3-loop, and 4-loop PWR designs from each of the PWR nuclear steam supply system (NSSS) vendors (i.e., Babcock and Wilcox (B&W), Combustion Engineering (CE), and Westinghouse). A total of 1,128 examinations of components for the three affected Item Numbers included in this proposed alternative were conducted on PWR pressurizer components.

A small number of flaws were identified during these examinations which required flaw evaluation. None of these flaws were found to be service induced. Out of a total of 1,128 examinations identified by the plants that responded to the survey that have been performed on the above item numbers, only four examinations (for Item No. B2.11) at two units of a single plant site identified flaws exceeding the acceptance criteria of ASME Code, Section XI. Flaw evaluations were performed to show acceptability of these indications and follow on examinations showed no change in flaw sizes since the original inspections. No other indications were identified in any in-scope components.

Table B-1 Summary of Survey Results

Item No.	No. of Examinations	No. of Reportable Indications
B2.11	269	4 (1)
B2.12	269	0
B3.110	590	0

Note:
1. Flaw evaluations were performed to show acceptability of these indications and follow on examinations showed no change in flaw sizes since the original inspections.

REFERENCE

B1. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.

APPENDIX C

Comparison of Braidwood Station, Byron Station, and Calvert Cliffs General Transients to the Transients Evaluated in EPRI Report

Comparison of Braidwood Station, Units 1 and 2 General Transients to the Transients Evaluated in Reference [C1]

Braidwood general transients are tracked by Exelon and the number of cycles encountered as of 2020 for the transients relevant to this request are provided in Table C-1 [C2]. As indicated in Reference [C1], not all the transients tracked by Exelon for Braidwood are required for this request. Table 5-5 of Reference [C1] identified the significant cycles to be used in the evaluation based on expected cycles from a fleet fatigue monitoring review. The Reference [C1] report considered the heatup/coodown and loss of load. Leakage tests are conducted as an integral part of the plant heatup process; therefore, no additional cycles were included solely for leakage testing. Braidwood would also expect to perform operating leakage testing, instead of hydrostatic testing, following any potential Braidwood Units 1 and 2 pressurizer repairs required by Paragraph IWA-4540(a) of ASME Section XI, in the future. The report considered 300 heatup and cooldown transients for 60 years of operation. The loss of load condition was the most limiting transient, but the cycles were increased to account for other similar events (reactor trip, loss of flow, and loss of power) and thus increased the number of cycles to 360.

For comparison with Table 5-6 of Reference [C1], the actual number of cycles in Table C-1 were projected to 60 years. The comparison of Braidwood general transients to the requirements in Reference [C1] is shown in Table C-2.

Table C-1
Braidwood Station, Units 1 and 2, General Transients Applicable to This Request [C2-C7]

Transient Name		Braidwood Station, Unit 1			Braidwood Station, Unit 2		
		Up to 2020	**60-Year Projected**	**Maximum Cycles (Controlling Limit)**	**Up to 2020**	**60-Year Projected**	**Maximum Cycles (Controlling Limit)**
1	RCS Heat Up	40	72	200	43	79	200
2	RCS Cool Down	39	70	200	51	94	200
3	Pressurizer Cooldown	40	72	200	41	75	200
4	Reactor Trips	6	11	230	38	69	230
5	Reactor Trips w/Subsequent Cooldown	11	20	160	3	5	160
6	Reactor Trip w/ Subsequent SI	3	5	10	0	0	10
7	50% Step Load Decrease with Steam Dump (See Below)	See Steps 7a, 7b, 7c, 7d	See Steps 7a, 7b, 7c, 7d	See Steps 7a, 7b, 7c, 7d	See Steps 7a, 7b, 7c, 7d	See Steps 7a, 7b, 7c, 7d	See Steps 7a, 7b, 7c, 7d
7a	Unload @5%/min	104	187	12240	86	158	13200

Transient Name		**Braidwood Station, Unit 1**			**Braidwood Station, Unit 2**		
		Up to 2020	**60-Year Projected**	**Maximum Cycles (Controlling Limit)**	**Up to 2020**	**60-Year Projected**	**Maximum Cycles (Controlling Limit)**
7b	Step Load 10% Decrease	3	5	2000	5	9	2000
7c	Unloading, 15%-0% Power	17	31	500	15	28	500
7d	Large Step Load Decrease	2	4	200	1	2	200
8	Loss of Load	1	2	80	1	2	80
9	Loss of Offsite AC Power	1	2	40	2	4	40
10	Loss of Flow in One RC Loop Only (BRW below)	See Steps 10a, 10b	See Steps 10a, 10b	See Steps 10a, 10b	See Steps 10a, 10b	See Steps 10a, 10b	See Steps 10a, 10b
10a	Partial Loss of Flow	1	2	80	1	2	80
10b	Complete Loss of Flow	0	0	5	1	2	5

Note:

1. Allowable limits and totals are from the Braidwood, Unit 1 and 2, Fatigue Monitoring Reports (December 2020) Work Orders 05107062 and 05107063 (Procedure BwVP 850-7).
2. 60-year projection is based on Braidwood, Unit 1 and 2, Semi-Annual Fatigue Monitoring Report (January 2021) under Work Orders 05064062 and 05064063.

Table C-2
Comparison of Braidwood Station, Units 1 and 2, General Transients to the Transients Evaluated in Reference [C1]

Transient	Number of Cycles for 60 Years from Reference [C1]	Braidwood Station, Unit 1 60-Year Projections from Table C-1	Braidwood Station, Unit 2 60-Year Projections from Table C-1
Heatup / Cooldown	300	72	94
Loss of Load (Sum of Reactor Trips, 50% Step Load Decrease with Steam Dump, Loss of Load, Loss of Flow in One RC Loop Only, and Loss of Offsite AC Power Events)	360	269	281

REFERENCES

C1. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
C2. Braidwood Station, Unit 1, December Fatigue Monitoring Report (Monthly), Work Order 05107062.
C3. Braidwood Station, Unit 2, December Fatigue Monitoring Report (Monthly), Work Order 05107063.
C4. Braidwood Station, Unit 1, Semi-Annual Report (January), Work Order 05064063.
C5. Braidwood Station, Unit 2, Semi-Annual Report (January), Work Order 05064062.
C6. Procedure BwVP 850-7, *Operational Transient Cycle Counting*.
C7. WCAP-15966, *Evaluation of Pressurizer Insurge / Outsurge Transients for Byron and Braidwood, 2002*.

Comparison of Byron Station, Units 1 and 2, General Transients to the Transients Evaluated in Reference [C8]

Byron general transients are tracked by Exelon and the number of cycles encountered as of 2020 for the transients relevant to this request are provided in Table C-3 [C9]. As indicated in Reference [C8], not all the transients tracked by Exelon for Byron are required for this request. Table 5-5 of Reference [C8] identified the significant cycles to be used in the evaluation based on expected cycles from a fleet fatigue monitoring review. The Reference [C8] report considered the heatup/coodown and loss of load. Leakage tests are conducted as an integral part of the plant heatup process; therefore, no additional cycles were included solely for leakage testing. Byron would also expect to perform operating leakage testing, instead of hydrostatic testing, following any potential Byron Units 1 and 2 pressurizer repairs, required by Paragraph IWA-4540(a) of ASME Section XI, in the future. The report considered 300 heatup and cooldown transients for 60 years of operation. The loss of load condition was the most limiting transient, but the cycles were increased to account for other similar events (reactor trip, loss of flow, and loss of power) and thus increased the number of cycles to 360.

For comparison with Table 5-6 of Reference [C8], the actual number of cycles in Table C-3 were projected to 60 years. The comparison of Byron general transients to the requirements in Reference [C8] is shown in Table C-4.

Table C-3
Byron Station, Units 1 and 2, General Transients Applicable to This Request [C9]

Transient Name	Byron Station, Unit 1			Byron Station, Unit 2		
	Up to 2020	60-Year Projected	Maximum Cycles (Controlling Limit)	Up to 2020	60-Year Projected	Maximum Cycles (Controlling Limit)
Heat Up@ <100°F/hr	38	66	200	34	62	200
Cooldown@ <100°F/hr	38	66	200	34	62	200
Reactor Trips	5	9	230	7	13	230
50% Step Load Decrease with Steam Dump	2	4	200	3	6	200
Loss of Load	3	6	80	1	2	80
Loss of Flow in One RC Loop Only	0	0	80	0	0	80
Loss of Offsite AC Power	1	2	40	3	6	40

Note:

1. Allowable limits and totals are from the Byron, Unit 1 and 2, Annual Fatigue Monitoring Report (2020), EC 633359, Revision 0.
2. 60-year projection is based on Byron, Unit 1 and 2, Annual Fatigue Monitoring Report (2020), EC 633359, Revision 0.

Table C-4
Comparison of Byron Station, Units 1 and 2, General Transients to the Transients Evaluated in Reference [C8]

Transient	Number of Cycles for 60 Years from Reference [C8]	Byron Station, Unit 1 60-Year Projections from Table C-3	Byron Station, Unit 2 60-Year Projections from Table C-3
Heatup / Cooldown	300	66	62
Loss of Load (Sum of Reactor Trips, 50% Step Load Decrease with Steam Dump, Loss of Load, Loss of Flow in One RC Loop Only, and Loss of Offsite AC Power Events)	360	21	27

REFERENCES

C8. Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.

C9. EC 633359, Revision 0, *Annual Fatigue Monitoring Report 2020 Unit 1 & Unit 2*.

Comparison of Calvert Cliffs, Units 1 and 2 General Transients to the Transients Evaluated in Reference [C10]

Calvert Cliffs general transients are tracked by Exelon and the number of cycles encountered as of 2018 for the transients relevant to this request are provided in Table C-5 [C11]. As indicated in Reference [C10], not all the transients tracked by Exelon for Calvert Cliffs are required for this request. Table 5-5 of Reference [C10] identified the significant cycles to be used in the evaluation based on expected cycles from a fleet fatigue monitoring review. The Reference [C10] report considered the heatup/coodown and loss of load. Leakage tests are conducted as an integral part of the plant heatup process; therefore, no additional cycles were included solely for leakage testing. Calvert Cliffs would also expect to perform operating leakage testing, instead of hydrostatic testing, following any potential Calvert Cliffs Units 1 and 2 pressurizer repairs, required by Paragraph IWA-4540(a) of ASME Section XI, in the future. The report considered 300 heatup and cooldown transients for 60 years of operation. The loss of load condition was the most limiting transient, but the cycles were increased to account for other similar events (reactor trip, loss of flow, and loss of power) and thus increased the number of cycles to 360.

For comparison with Table 5-6 of Reference [C10], the actual number of cycles in Table C-5 were projected to 60 years. The comparison of Calvert Cliffs general transients to the requirements in Reference [C10] is shown in Table C-6.

Table C-5
Calvert Cliffs, Units 1 and 2, General Transients Applicable to This Request [C11]

Transient Name	Calvert Cliffs, Unit 1			Calvert Cliffs, Unit 2		
	Up to 2018	60-Year Projected	Maximum Cycles (Controlling Limit)	Up to 2018	60-Year Projected	Maximum Cycles (Controlling Limit)
Pressurizer Heat Up	121	152	500	93	120	500
Pressurizer Cooldown	120	149	500	91	117	500
Reactor Trips	134	171[(2)]	164	112	147	164
Plant Loading 15-100% Power	107	146	6150	90	123	6150
Plant Unloading 100%-15% Power	101	137	6150	84	114	6150
Loss of Load	2	6	40	2	6	40
Partial Loss of RCS Flow	10	12	40	9	12	40
Loss of Offsite AC Power[(1)]	NA	NA	NA	NA	NA	NA
Step Load Decrease 10%	378	457	820	289	360	820
Step Load Increase 10%	382	468	820	279	344	820

Note:
1. Loss of Offsite AC power is not a transient that is required to be analyzed as part of the Calvert Cliffs design basis transients.

2. The Reactor Trips Transient for Unit 1 is projected to exceed the design allowable number of cycles for 60-Years. While the number of this one transient exceeds the allowable number of transient cycles, the 2018 fatigue analysis determined the fatigue usage still remains below the allowable value of 1.0. All locations monitored for fatigue are currently below the design allowable limit of 1.0 and are projected to remain below the design allowable limit of 1.0 through 60 years of operation.

**Table C-6
Comparison of Calvert Cliffs, Units 1 and 2, General Transients to the Transients Evaluated in Reference [C10]**

Transient	Number of Cycles for 60 Years from Reference [C10]	Calvert Cliffs, Unit 1 60-Year Projections from Table C-5	Calvert Cliffs, Unit 2 60-Year Projections from Table C-5
Heatup / Cooldown	300	152/149	120/117
Loss of Load (Sum of Reactor Trips, 50% Step Load Decrease with Steam Dump, Loss of Load, Loss of Flow in One RC Loop Only, and Loss of Offsite AC Power Events)	360	189	165

REFERENCES

C10. Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
C11. ECP-18-000545, *Fatigue Plant Transient Review*.

APPENDIX D

Comparison of Braidwood Station, Byron Station, and Calvert Cliffs Insurge/Outsurge Transients to the Insurge/Outsurge Transients Evaluated EPRI Report

Comparison of Braidwood Station, Units 1 and 2, Insurge/Outsurge Transients to the Insurge/Outsurge Transients Evaluated in Reference [D1]

Braidwood Insurge/Outsurge transients are provided in Table D-1 [D2-D7]. The temperature differences (ΔTs) identified in Table D-1 are combined conservatively by summing all the events into the 320°F ΔT bin. It should be noted that the transients in Table D-1 reflect 40 years of operation, so for comparison with Table 5-10 of Reference [D1], they are extrapolated to 60 years by multiplying by 1.5. With this conservative treatment of the Insurge/Outsurge transients, the comparison of Braidwood Insurge/Outsurge transients to the requirements in Reference [D1] is shown in Table D-2. The results of Table D-2 indicate that the Braidwood Insurge/Outsurge transients are bounded by those in Reference [D1].

Table D-1
40-Year Insurge/Outsurge Transients for Braidwood Station, Units 1 and 2 [D2-D7]

No.	Transient Name (1,2,3)	Unit 1			Unit 2		
		Up to 2020 [D2]	60-Year Projected [D4](5)	Allowable Limit [D7](4)	Up to 2020 [D3]	60-Year Projected [D5](5)	Allowable Limit [D7](4)
1	PZR I/O SURGE MOPHU320	4	10	56	4	10	56
2	PZR I/O SURGE MOPHU300	2	5	20	0	0	20
3	PZR I/O SURGE MOPHU280	3	8	21	0	0	21
4	PZR I/O SURGE MOPHU270	9	23	70	6	16	70
5	PZR I/O SURGE MOPCD320	0	0	41	0	0	41
6	PZR I/O SURGE MOPCD310	0	0	15	0	0	15
7	PZR I/O SURGE MOPCD300	1	3	20	2	5	20
8	PZR I/O SURGE MOPCD270	1	3	76	0	0	76
9	PZR I/O SURGE MOPCD250	4	10	15	8	21(6)	15

Notes:
1. The Transient Name is MOPXXnnn, where MOP = post Modified Operating Procedures, XX = HU for insurge/outsurge transients that occur during Heatup events, or CD for insurge/outsurge transients that occur during Cooldown events, and nnn = temperature difference, delta T, between the RCS piping at the beginning of the transient and pressurizer temperature at the end of the transient
2. Insurge/Outsurge determination is based on WCAP-15966
3. Braidwood does not explicitly monitor the breakdown of the transients shown in this table. Rather, the number of cycles shown in this table were used in the governing fatigue evaluations for the pressurizer surge nozzles. Braidwood does NOT currently monitor the environmental fatigue usage factor for the surge nozzle but is expected to do so with implementation of WESTEMs as part of license renewal commitments for the station.
4. Per Note 2 (WCAP-15966) the allowable insurge/outsurge numbers were used to evaluate the stresses for Braidwood. As such, these numbers are the same for 40 years and 60 years.
5. 60-year projection is based on Braidwood, Unit 1 and 2, Semi-Annual Fatigue Monitoring Report (January 2021) under Work Orders 05064062 and 05064063.
6. In Reference [D5], PZR I/O SURGE MOPCD250 was identified as reaching 53.33% of the allowable limit for Unit 2, and was projected to exceed the allowable limit in 2033. This projection is skewed based on the occurrences in 2008 and 2009, when three of the events occurred during a refueling outage cool down. Except for one event in 2014 during the A2R17 refueling outage, there have been zero occurrences of the PZR I/O SURGE MOPCD250 events between 2010 and 2020. Based on the latest trend, the 60-Year Projected count should decrease as the plant reaches it’s PEO and the “projected year to reach the limit” will continue to increase beyond 2033.

**Table D-2
Comparison of Braidwood Station, Units 1 and 2, Insurge/Outsurge Transient Temperature Differences and Numbers of Cycles with the Insurge/Outsurge Transient Date from Reference [D1]**

ΔT (ºF)(1)	60-Year No. of Cycles From Reference [D1]	Braidwood Station, Unit 1 Cycles Projected to 60 Years of Operation	Braidwood Station, Unit 2 Cycles Projected to 60 Years of Operation
330	600	0	0
320	3,000	62	52
103	1,500	0	0

Notes:
1. ΔT is the temperature difference between the pressurizer fluid temperature and the fluid temperature in the surge nozzle.

REFERENCES

D1. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
D2. Braidwood Station, Unit 1, December Fatigue Monitoring Report (Monthly), Work Order 05107062.
D3. Braidwood Station, Unit 2, December Fatigue Monitoring Report (Monthly), Work Order 05107063.
D4. Braidwood Station, Unit 1, Semi-Annual Report (January), Work Order 05064063.
D5. Braidwood Station, Unit 2, Semi-Annual Report (January), Work Order 05064062.
D6. Procedure BwVP 850-7, *Operational Transient Cycle Counting*.
D7. WCAP-15966, *Evaluation of Pressurizer Insurge / Outsurge Transients for Byron and Braidwood, 2002*.

Comparison of Byron Station, Units 1 and 2, Insurge/Outsurge Transients to the Insurge/Outsurge Transients Evaluated in Reference [D8]

Byron Insurge/Outsurge transients are provided in Table D-3 [D9-D14]. The temperature differences (ΔTs) identified in Table D-3 are combined conservatively by summing all the events into the 320°F ΔT bin. It should be noted that the transients in Table D-3 reflect 40 years of operation, so for comparison with Table 5-10 of Reference [D8], they are extrapolated to 60 years by multiplying by 1.5. With this conservative treatment of the Insurge/Outsurge transients, the comparison of Byron Insurge/Outsurge transients to the requirements in Reference [D8] is shown in Table D-4. The results of Table D-4 indicate that the Byron Insurge/Outsurge transients are bounded by those in Reference [D8].

Table D-3
40-Year Insurge/Outsurge Transients for Byron Station, Units 1 and 2 [D9-D14]

No.	Transient Name (1,2)	WCAP-15966 Past Total Count [D10]	Unit 1			Unit 2		
			Up to 2020 [D11](2)	60-Year Projected(3)	Allowable Limit [D10](4)	Up to 2020 [D11](2)	60-Year Projected(3)	Allowable Limit [D10](4)
1	PZR I/O Surge-MOPHU320	10	3	20	35	3	20	35
2	PZR I/O Surge-MOPHU310	5	0	5	17	0	5	17
3	PZR I/O Surge-MOPHU300	5	1	9	17	1	9	17
4	PZR I/O Surge-MOPHU280	15	0	15	52	1	19	52
5	PZR I/O Surge-MOPHU270	12	2	19	42	0	12	42
6	PZR I/O Surge-MOPHU250	11	8	36	37	10	44	37
7	PZR I/O Surge-MOPCD320	7	0	7	24	1	11	24
8	PZR I/O Surge-MOPCD310	9	0	9	31	0	9	31
9	PZR I/O Surge-MOPCD300	9	0	9	31	0	9	31
10	PZR I/O Surge-MOPCD290	11	0	11	38	0	11	38
11	PZR I/O Surge-MOPCD280	4	0	4	14	0	4	14
12	PZR I/O Surge-MOPCD270	11	0	11	38	1	15	38
13	PZR I/O Surge-MOPCD250	7	3	17	24	6	27	24

Notes:
1. The Transient Name is PZR I/O Surge-MOP XX nnn, where XX = HU for insurge/outsurge transients that occur during Heatup events, or CD for insurge/outsurge transients that occur during Cooldown events, and nnn = the temperature difference, ΔT, between the pressurizer fluid temperature and the fluid temperature in the surge nozzle.
2. Byron has explicitly monitored the breakdown of the transients shown in this table since May 2008, when BVP 900-3, Revision 6 [D11] was issued. This monitoring was implemented to confirm the MOP strategies recommended in WCAP-14950 [D14] are effective and to ensure that the projections in WCAP-15966 [D10] remain bounding.
3. The projection for the number of Insurge/Outsurge Transients over 60 years of operation is equal to the sum of the conservatively estimated past events as documented in WCAP-15966 [D10] and the number of events recorded between 2008 and 2020 [D9] increased to assume the same rate of occurrence until the end of the 60 year operating period.
4. The Allowable Limit is the sum of the conservatively estimated past events as documented in WCAP-15966 [D10] and the projected number of future MOP Heatup/Cooldown events assumed in WCAP-15966 [D10].

Table D-4
Comparison of Byron Station, Units 1 and 2, Insurge/Outsurge Transient Temperature Differences and Numbers of Cycles with the Insurge/Outsurge Transient Date from Reference [D8]

ΔT (ºF)(1)	60-Year No. of Cycles from Reference [D8]	Byron Unit 1 Cycles Projected to 60 Years of Operation	Byron Unit 2 Cycles Projected to 60 Years of Operation
330	600	27(2)	31(2)
320	3,000	172(3)	195(3)
103	1,500	53(4)	71(4)

Notes:
1. ΔT is the temperature difference between the pressurizer fluid temperature and the fluid temperature in the surge nozzle.
2. Byron has an administrative limit of 320°F on system ΔT. WCAP-15966 [D10] did identify a small number of events that exceeded 320°F on system ΔT and assumed those events to be 320°F for the purposes of developing the system ΔT distribution in the analysis. Based on this precedence, the number of cycles at ΔT = 330°F is conservatively considered to be equal to sum of all heatup and cooldown events in Table D-3 for ΔT = 320°F, since Byron does not specifically monitor for transients with a temperature difference of 330°F.
3. The number of cycles at ΔT = 320°F is conservatively considered to be equal to sum of all events in Table D-3.
4. The number of cycles at ΔT = 103°F is conservatively considered to be equal to sum of the heatup and cooldown events in Table D-3 for ΔT = 250°F, since Byron does not specifically monitor for transients with a temperature difference of 103°F. Byron does count any event with ΔT >80°F and ≤250°F in as applicable 250°F surge condition. Therefore, the number of events in Table D-3 for ΔT = 250°F is conservatively bounding.

REFERENCES

D8. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.

D9. EC 633359, Revision 0, *Annual Fatigue Monitoring Report 2020 Unit 1 & Unit 2*.

D10. WCAP-15966, *Evaluation of Pressurizer Insurge/Outsurge Transients for Byron and Braidwood*, Rev. 0, dated December 2002.

D11. BVP 900-3, *Documentation of Operating Plant/Component Cyclic or Transient Events*, Rev. 6, issued May 9, 2008.

D12. BVP 900-3, *Documentation of Operating Plant/Component Cyclic or Transient Events*, Rev. 8 (current revision), issued February 27, 2012.

D13. Exelon Procedure ER-AA-470, *Fatigue and Transient Monitoring Program*, Rev. 8, issued January 30, 2019.

D14. WCAP-14950, *Mitigation and Evaluation of Pressurizer Insurge/Outsurge Transients*, February 1998.

Comparison of Calvert Cliffs, Units 1 and 2 Insurge/Outsurge Transients to the Insurge/Outsurge Transients Evaluated in Reference [D15]

Calvert Cliffs does not track individual thermal transients as it is presented in the EPRI Report. Instead, the plant performs stress-based fatigue monitoring for the relevant surge nozzle locations that tracks Fatigue Usage (U) and Environmental Assisted Fatigue Usage (UEN) values to ensure they remain below the allowable value of 1.0 as shown in Tables D-5 and D-6 [D16]. As a result, instead of tabulated transients, the current U and UEN estimates are provided for the subject welds for Calvert Cliffs and their projections out to the current end-of-license operating period (60 years). The results of Table D-5 and D-6 indicate that the actual Calvert Cliffs fatigue values are well below the design limits and are satisfactory through 60 years of operation.

Table D-5
General Transients Fatigue Usage (U) Summary Report for Calvert Cliffs, Units 1 and 2 [D16]

Pressurizer Locations	Unit 1			Unit 2		
	U Up to 12/2018	U 60-Year Projected (7/21/2034)	U Maximum Cycles (Design Limit)	U Up to 12/2018	U 60-Year Projected (7/21/2034)	U Maximum Cycles (Design Limit)
Lower Head	0.1853	0.221	1.0	0.1168	0.151	1.0
Surge Nozzle	0.0173	0.019	1.0	0.0746	0.093	1.0

Notes:
1. The U values projected out to 60 years is calculated with the Fatigue Pro Software utilized by Calvert Cliffs.

Table D-6
General Transients Environmental Assisted Fatigue Usage (UEN) Summary Report for Calvert Cliffs, Units 1 and 2 [D15]

Pressurizer Locations	Unit 1			Unit 2		
	UEN Up to 12/2018	UEN 60-Year Projected (7/21/2034)	UEN Maximum Cycles (Design Limit)	UEN Up to 12/2018	UEN 60-Year Projected (7/21/2034)	UEN Maximum Cycles (Design Limit)
Lower Head	0.4548	0.543	1.0	0.5287	0.685	1.0
Surge Nozzle	0.0876	0.096	1.0	0.3806	0.495	1.0

Notes:
1. The UEN values projected out to 60 years is calculated with the Fatigue Pro Software utilized by Calvert Cliffs.

REFERENCES

D15. *Technical Bases for Inspection Requirements for PWR Pressurizer Vessel Head, Shell-to-Head and Nozzle-to-Vessel Welds*. EPRI, Palo Alto, CA: 2019. 3002015905, ADAMS Accession No. ML21021A271.
D16. ECP-18-000545, *Fatigue Plant Transient Review*.