ENCLOSURE 3

NEDO-33445 - Pressure and Temperature Limits Report (PTLR) Up to 25 and 38 Effective Full- Power Years (Non-Proprietary)

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TENNESSEE VALLEY AUTHORITY BROWNS FERRY NUCLEAR PLANT UNI 1

Pressure and Temperature Limits Report (PTLR) Up to 25 and 38 Effective Full-Power Years

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APPENDICES

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ABBREVIATIONS & ACRONYMS

Short Form	**Description**
%Cu	Weight percent Copper
%Ni	Weight percent Nickel
1/4T	¼ depth into the vessel wall from the inside diameter
3/4T	¾ depth into the vessel wall from the inside diameter
ASME	American Society of Mechanical Engineers
ART	Adjusted Reference Temperature
BAF	Bottom of Active Fuel
BFNP	Browns Ferry Nuclear Plant
BWR	Boiling Water Reactor
BWR/6	BWR Product Line 6
BWRVIP	BWR Vessel and Internals Project
CF	Chemistry Factor
CMTR	Certified Material Test Report
CRD	Control Rod Drive
EFPY	Effective Full Power Years
EPRI	Electric Power Research Institute
ESW	Electroslag Weld
FW	Feedwater
GEH	GE-Hitachi Nuclear Energy Americas LLC
GL	Generic Letter
ID	Inside Diameter
ISP	Integrated Surveillance Program
LTR	Licensing Topical Report
n/cm^2	neutrons per square centimeter (measure of fluence)
N16	BFNP Unit 1 Water Level Instrumentation Nozzle
NDT	Nil Ductility Transition
NRC	Nuclear Regulatory Commission
P/T	Pressure and Temperature
P-T	Pressure-Temperature
PTLR	Pressure and Temperature Limits Report
RCPB	Reactor Coolant Pressure Boundary
RCS	Reactor Coolant System
RG	Regulatory Guide
RPV	Reactor Pressure Vessel
RT_{NDT}	Reference Temperature of Nil Ductility Transition
RVID	Reactor Vessel Integrity Database (by NRC)
SAW	Submerged Arc Weld
SSP	Supplemental Surveillance Program
TAF	Top of Active Fuel
TS	Technical Specification
TVA	Tennessee Valley Authority
UFSAR	Updated Final Safety Analysis Report

Short Form	Description
US	United States
WLI	Water Level Instrumentation
WRC	Welding Research Council

1.0 Purpose

The purpose of the Browns Ferry Nuclear Plant (BFNP) Unit 1 Pressure and Temperature Limits Report (PTLR) is to present operating limits relating to:

1. Reactor Coolant System (RCS) Pressure versus Temperature limits during Heatup, Cooldown and Hydrostatic/Class 1 Leak Testing;
2. RCS Heatup and Cooldown rates;
3. Reactor Pressure Vessel (RPV) to RCS coolant ΔT requirements during Recirculation Pump startups;
4. RPV bottom head coolant temperature to RPV coolant temperature ΔT requirements during Recirculation Pump startups;
5. RPV head flange bolt-up temperature limits.

This report has been prepared in accordance with the requirements defined in Reference 6.2.

2.0 Applicability

This report is applicable to the BFNP Unit 1 RPV for up to 25 and 38 Effective Full Power Years (EFPY), representing a 60-year license.

The following Technical Specification (TS) is affected by the information contained in this report:

TS 3.4.9 RCS Pressure and Temperature (P/T) Limits

3.0 Methodology

The limits in this report were derived from the Nuclear Regulatory Commission (NRC)-approved methods listed in the specific revisions listed below:

1. The neutron fluence was calculated per Licensing Topical Report (LTR), *General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation*, NEDC-32983P-A, Revision 2, January 2006, approved in Reference 6.1.
2. The pressure and temperature limits were calculated per *GE Hitachi Nuclear Energy Methodology for Development of Reactor Pressure Vessel Pressure-Temperature Curves*, NEDC-33178P-A, Revision 1, June 2009, approved in Reference 6.2.
3. This revision of the pressure and temperature limits is to incorporate the following changes:
    - Application of GEH Topical Report for Pressure-Temperature (P-T) Curves
    - The Water Level Instrumentation (WLI) nozzle that occurs in the beltline region was fabricated from non-ferritic Inconel material and has been considered in the Adjusted Reference Temperature (ART) evaluation. The

material properties of the [[ ]] material have been considered with the fluence for the nozzle location.

- Application of new Integrated Surveillance Program (ISP) testing and analysis results from the BFNP Unit 2 surveillance capsule that are applicable to BFNP Unit 1.

3.1 Chemistry

The N16 WLI nozzle is defined as being within the beltline region, and is evaluated for ART. This nozzle is fabricated from non-ferritic Inconel materials. Therefore, the chemistry for the [[ ]] to evaluate the ART to represent this nozzle forging.

Chemistry for all other materials remains unchanged from those used in the development of the currently licensed P-T curves.

Surveillance materials are evaluated using the chemistries obtained from Boiling Water Reactor (BWR) Vessel and Internals Project (BWRVIP)-135, Revision 2, as presented in Section 3.4. It is noted that there are no best estimate chemistries for the BFNP Unit 1 beltline materials described in BWRVIP-135.

The Chemistry Factors (CFs) for all materials are calculated based upon the requirements of Regulatory Guide (RG) 1.99, Revision 2.

3.2 Initial Reference Temperature of Nil Ductility Transition

The N16 WLI nozzle is evaluated for ART. As the nozzle forging is fabricated from Inconel, for which fracture toughness evaluations are not required, the [[ ]] are used.

Surveillance materials are evaluated using the limiting initial RT_{NDT} of the beltline plate or weld material.

Initial RT_{NDT}s for all other beltline materials remain unchanged from those used in the development of the currently licensed P-T curves.

3.3 Adjusted Reference Temperature

The ART values for 25 and 38 EFPY included in Appendix B are developed considering the latest BWRVIP ISP data available that is representative of the applicable materials in the BFNP Unit 1 RPV (Reference 6.3). The surveillance data used in the BFNP Unit 1 ART calculations are not obtained from actual BFNP Unit 1 RPV test specimens. The ISP plate materials are not limiting with respect to the ART. The ISP weld is the limiting material; this value is considered in the development of the P-T curves because the ISP material is the identical heat to the material in the BFNP Unit 1 RPV.

The N16 nozzle ART is determined considering the initial RT_{NDT} [[ ]] material together with the fluence at the nozzle elevation.

3.4 Surveillance Program

As discussed in Appendix A, BFNP Unit 1 participates in the ISP. All three (3) of the surveillance capsules, installed at plant startup, remain in the vessel. As BFNP Unit 1 is not a host plant, the three (3) surveillance capsules have an ISP status designation of deferred (standby) per Reference 6.4.

BWRVIP-135, Revision 2 and Reference 6.5 provide the surveillance data considered in determining the chemistry and any adjusted CFs for the beltline materials.

Excerpt from BWRVIP-135, Revision 2:

[[

]]

For BFNP Unit 1, the ISP representative plate, heat [[ ]] target plate. This heat was contained in two (2) BFNP Unit 2 capsules that have been tested and analyzed. The resultant chemistry is [[ ]] Cu and [[ ]] Ni. The CF from RG 1.99, Revision 2 is [[ ]]. The fitted CF is [[ ]]; however, as the ISP material [[ ]] target material, the ART table evaluated the ISP plate material [[ ]]. This material [[ ]] in determining the limiting ART for the PT curves; this [[ ]] the limiting material.

Excerpt from BWRVIP-135, Revision 2:

[[

]]

For BFNP Unit 1, the ISP representative weld, heat [[ ]] target weld. This heat was contained in Supplemental Surveillance capsules that have been tested and analyzed. The resultant chemistry is [[ ]] Cu and [[ ]] Ni. The CF from RG 1.99 is [[ ]]. The fitted CF is [[ ]], calculated using surveillance data. The scatter in this data [[ ]]. Because the [[ ]] in the ART calculation. In addition, the [[ ]] This material [[ ]] the limiting ART for the PT curves.

Excerpt from BWRVIP-135, Revision 2:

[[

]]

Should actual surveillance capsules be withdrawn and tested from the BFNP Unit 1 RPV (e.g., status change to be an ISP host plant under the BWRVIP ISP), compliance with 10 CFR 50 Appendix H requirements on reporting test results and evaluations on the effects to plant operations parameters (e.g., P-T limits, hydrostatic and leak test conditions) will be in accordance with Section 3 of Reference 6.3.

3.5 Reactor Coolant Pressure Boundary

American Society of Mechanical Engineers (ASME) Code Section XI, Appendix G, Article G-3000, paragraph G-3100 states that for materials "used for piping, pumps, and valves for which impact tests are required (NB-2311), the tests and acceptance standards of Section III, Division 1 are considered to be adequate to prevent non-ductile failure under the loadings and with the defect sizes encountered under normal, upset, and testing conditions. Level C and Level D Service Limits should be evaluated on an individual case basis (G-2300)." As described in Section 4.3 of Reference 6.1, [[ ]] the development of all non-beltline PT limits.

ASME Section III, Paragraph NB-2332 states that "Pressure-retaining materials (other than bolting) with nominal thickness over 2.5 inches for piping (pipe and tubes) and materials for pumps, valves and fittings with any pipe connection of nominal wall thickness greater than 2.5 inches shall meet the requirements of NB-2331. The lowest service temperature shall be not lower than RT_{NDT} + 100°F unless a lower temperature is justified by following the methods similar to those contained in Article G-2000." All BFNP Unit 1 ferritic Reactor Coolant Pressure Boundary (RCPB) piping has nominal wall thicknesses less than 2.5 inches. Other Class 1 RCPB components are significantly smaller with nominal wall thicknesses well below 2.5 inches, including all of the ferritic RCPB components. The lowest service temperatures may be less than 250°F in some cases; however the methods of Appendix G have been followed to justify lower temperatures. Therefore, the requirements of NB-2332 have been met, and there are no ferritic RCPB piping components that require consideration in the RPV P-T curves for BFNP Unit 1.

The [[ ]], are more limiting relative to stress than any of the Class 1 ferritic branch piping in the RCPB.

With respect to concern regarding irradiation effects on RCPB piping, a qualitative fluence assessment was performed. With a 38 EFPY peak surface Inside Diameter (ID) fluence of 1.58e18 n/cm^2 as the maximum fluence of concern, accrual of fluence greater than 1.0e17 n/cm^2 outside the vessel for 38 EFPY is not expected, based on historical calculations of flux vs. vessel thickness.

As discussed in the BFNP Updated Final Safety Analysis Report (UFSAR), it is noted that the manner in which the RCPB was designed and constructed was to ensure a high degree of integrity with adequate toughness throughout the plant life. The RCPB components were designed and fabricated, and are maintained and tested such that adequate assurance is provided that the boundary will behave in a non-brittle manner throughout the life of the plant.

3.6 Future Changes

Changes to the curves, limits, or parameters within this PTLR, based upon new irradiation fluence data of the RPV, or other plant design assumptions in the UFSAR, can be made pursuant to 10 CFR 50.59, provided the above methodologies are utilized. The revised PTLR shall be submitted to the NRC upon issuance.

4.0 Operating Limits

The P-T curves provided in this report represent steam dome pressure versus minimum vessel metal temperature and incorporate the appropriate non-beltline limits and irradiation embrittlement effects in the beltline region.

The operating limits for pressure and temperature are required for three categories of operation: (a) hydrostatic pressure tests and leak tests, referred to as Curve A; (b) non-nuclear heatup/cooldown (core not critical), referred to as Curve B; and (c) core critical operation, referred to as Curve C.

Complete P-T curves were developed for 25 and 38 EFPY. The P-T curves are provided in Figures 1 through 4, and a tabulation of the curves is included in Table 1 (25 EFPY) and Table 2 (38 EFPY).

Other temperature limits applicable to the RPV and controlled by the Technical Specification are:

- Heatup and Cooldown rate limit during Hydrostatic and Class 1 Leak Testing: ≤ 15°F/hour.
- Normal Operating Heatup and Cooldown rate limit: ≤ 100°F/hour.
- RPV bottom head coolant temperature to RPV coolant temperature ΔT limit during Recirculation Pump startup: ≤ 145°F.

- Recirculation loop coolant temperature to RPV coolant temperature ΔT limit during Recirculation Pump startup: ≤ 50°F.
- RPV flange and adjacent shell temperature limit: ≥ 80°F.

5.0 Discussion

The procedures described in References 6.1 and 6.2 were used in the development of the P-T curves for BFNP Unit 1.

The method for determining the initial RT_{NDT} for all vessel materials is defined in Section 4.1.2 of Reference 6.2. Initial RT_{NDT} values for all vessel materials considered are presented in tables in Appendix B of this report.

In order to ensure that the limiting vessel discontinuity has been considered in the development of the P-T curves, the methods in Sections 4.3.2.1 and 4.3.2.2 of Reference 6.2 for the non-beltline and beltline regions, respectively, are applied.

In order to determine how much to shift the P-T curves, an evaluation is performed using Tables 4-4a and 4-5a from NEDC-33178P-A (Reference 6.2). These tables define the [[ ]] curves. Each component listed in these tables is [[ ]] for each component. The required temperature is then determined by [[ ]], thereby resulting in the required T for the curve. As the upper vessel curve is initially based on the [[ ]] T-RT_{NDT}, all resulting T values are compared to the [[ ]]. The [[ ]] the upper vessel curve. The same method is applied for the [[ ]] curve. In this manner, it is assured that each curve bounds the [[ ]] that is represented.

For the BFNP Unit 1 upper vessel curve, the maximum T value from the method described above is [[ ]]. The initial required T-RT_{NDT} for the [[ ]]; this is then adjusted by the BFNP Unit 1-specific [[ ]], resulting in [[ ]]. Comparing this to the other components bounded by the upper vessel curve, the limiting value is for the [[ ]]. The required T-RT_{NDT} for the [[ ]], which is [[ ]]. It is seen that the resulting T required for the [[ ]]. As [[ ]] is limiting, the BFNP Unit 1 upper vessel curve is based on an RT_{NDT} of [[ ]]. As noted above, this calculation was performed for each component shown in Table 4-4a of NEDC-33178P-A (Reference 6.2); only the limiting cases are presented here.

For the BFNP Unit 1 bottom head or CRD [[ ]], the maximum T value from the method described above is [[ ]]. The required T-RT_{NDT} for the [[ ]]; this is adjusted by the BFNP Unit 1-specific maximum [[ ]], resulting in [[ ]]. Comparing this to the next limiting value, the required T-RT_{NDT} is [[ ]], which is added to the [[ ]]. It is seen that the resulting T required for the [[ ]]. As [[ ]], the BFNP Unit 1 bottom head (CRD) curve is based on an [[ ]]. As noted above, this calculation was performed for each component shown in Table 4-5a of NEDC-33178P-A (Reference 6.2); only the limiting case is presented here.

Appendix H of NEDC-33178P-A (Reference 6.2) contains the details of an analysis performed to determine the baseline requirement (non-shifted) for the [[ ]]. It can be seen in Section H.5 of Appendix H that the stresses developed in this finite element analysis demonstrated that the [[ ]], resulting in a baseline non-shifted required T-RT_{NDT} of [[ ]]. Therefore, considering the determination of the required shift from the paragraph above for [[ ]], calculations for all components listed in Table 4-5a of NEDC-33178P-A were compared to the CRD T, which is [[ ]] (where [[ ]] materials). Therefore, the shift for the bottom head [[ ]].

For BFNP Unit 1, the limiting surveillance material, [[ ]], was considered using [[ ]] as defined in Appendix I of Reference 6.2. This procedure was used because the target vessel material and the surveillance material [[ ]]. As this material is a [[ ]], the use of the [[ ]] is considered.

The calculated value of [[ ]] material for the beltline P-T curves.

For BFNP Unit 1, there are thickness discontinuities in the vessel: (1) between the bottom head upper and lower torus; and (2) between the bottom head torus and the support skirt attachment. The P-T curves defined in Section 4.3 of Reference 6.2 are based upon an RT_{NDT} of 56°F for the bottom head [[ ]], and 51°F for the upper vessel. The 25 EFPY beltline curves are based on an ART of 128°F, and the 38 EFPY beltline curves are based on an ART of 146°F. Curves based on these temperatures bound the requirements due to the beltline thickness discontinuities.

The ART of the limiting beltline material is used to adjust the beltline P-T curves to account for irradiation effects. RG 1.99, Revision 2 provides the methods for determining the ART. The basis for the difference in the margin terms in Tables B-4 and B-5 is due, in part, to the effective fluence associated with 25 and 38 EFPY. For many of the BFNP Unit 1 materials, the margin term is dependent on the ΔRT_{NDT}. This is consistent with Position 1.1 of RG 1.99, Revision 2, which provides the methodology for determining ART. The final paragraph of this section of the RG states that σ_Δ (standard deviation for ΔRT_{NDT}) is 17°F for plates and 28°F for welds, but that σ_Δ need not exceed 0.5*ΔRT_{NDT}. The BFNP Unit 1 ART calculation has incorporated the use of

0.5*ΔRT_{NDT} for all materials, where applicable. The full margin term was used for the [[ ]].

The vessel beltline copper and nickel values were obtained from plant-specific vessel purchase order records, Certified Material Test Reports (CMTRs), or are values previously approved by the NRC, and remain unchanged from previous submittals.

The pressure head for the beltline hydrostatic test curve (Curve A) for BFNP Unit 1 is [[ ]]. This is determined using the height of the vessel and the elevation of the bottom of active fuel. The full vessel pressure head is [[ ]]. This pressure is used in the P-T curve analysis, considered in the determination of K_I for the bottom head curve as discussed in Sections 4.3.2.1.1 and 4.3.2.2.2 of the LTR.

The P-T curves for the non-beltline region were conservatively developed for a BWR [[ ]] with nominal ID of [[ ]]. As discussed in Section 4.3.2.1.1 of the LTR, if the plant-specific result of Equation 4-3 is greater than that of the [[ ]] from Equation 4-2, the user is directed to perform a plant-specific evaluation. The plant-specific BFNP Unit 1 geometry demonstrates that it is bounded by the Equation 4-2 result:

BFNP Unit 1: $R / t^{1/2}$ = [[ ]]

The analysis is therefore considered appropriate for BFNP Unit 1. The [[ ]] was adapted to the conditions at BFNP Unit 1 using plant-specific RT_{NDT} values for the RPV.

The peak RPV ID fluence used in the P-T curve evaluation for BFNP Unit 1 at 25 EFPY is 1.01e18 n/cm^2 and at 38 EFPY is 1.58e18 n/cm^2. These values were calculated using methods that comply with the guidelines of RG 1.190, (as discussed in Reference 6.1). This fluence applies to the lower-intermediate shell plates and longitudinal welds. The fluence is adjusted for the lower plates, associated longitudinal welds, and the girth weld based upon the axial fluence distribution calculated as part of the fluence evaluation; hence, the peak ID surface fluence for these components is 8.14e17 n/cm^2 for 25 EFPY and 1.28e18 n/cm^2 for 38 EFPY. Similarly, the fluence is adjusted for the N16 nozzle based upon the axial fluence distribution; hence, the peak ID surface fluence used for this component is 3.04e17 n/cm^2 for 25 EFPY and 4.77e17 n/cm^2 for 38 EFPY.

The P-T curves for the heatup and cooldown operating conditions at a given EFPY apply for both the 1/4T and 3/4T locations. When combining pressure and thermal stresses, it is usually necessary to evaluate stresses at the 1/4T location (inside surface flaw) and the 3/4T location (outside surface flaw). This is because the thermal gradient tensile stress of interest is in the inner wall during cooldown and the outer wall during heatup. However, as a conservative simplification, the thermal gradient stress at the 1/4T location is assumed to be tensile for both heatup and cooldown. This results in the approach of applying the maximum tensile stress at the 1/4T location. This approach is conservative because irradiation effects cause the allowable toughness, K_{Ir}, at 1/4T to be less than that at 3/4T for a given metal temperature. This approach causes no operational difficulties, because the BWR is at steam saturation conditions during normal operation, well above the heatup/cooldown curve limits.

For the core not critical curve (Curve B) and the core critical curve (Curve C), the P-T curves specify a coolant heatup and cooldown temperature rate of ≤ 100°F/hr for which the curves are applicable. However, the core not critical and the core critical curves were also developed to bound transients defined on the RPV thermal cycle diagram and the nozzle thermal cycle diagrams. For the hydrostatic pressure and leak test curve (Curve A), a coolant heatup and cooldown temperature rate of ≤ 15°F/hr must be maintained. The P-T limits and corresponding heatup/cooldown rates of either Curve A or B may be applied while achieving or recovering from test conditions. Curve A applies during pressure testing and when the limits of Curve B cannot be maintained.

As shown in Tables B-4 and B-5, the [[ ]]. However, the material is contained in the [[ ]]. When comparing the required T-RT_{NDT} for the [[ ]] provides a more restrictive curve. This is due to the reduced [[ ]] as discussed in Section 4.3.2.2.2 of the LTR. Therefore, for BFNP Unit 1, the axial electroslag weld heat is the limiting material for the beltline region for 25 and 38 EFPY. The initial RT_{NDT} for electroslag weld heat material is 23.1°F. The generic pressure test P-T curve is applied to the BFNP Unit 1 beltline curve by shifting the P vs. (T - RT_{NDT}) values to reflect the ART value of 128°F for 25 EFPY and 146°F for 38 EFPY.

Using the fluence discussed above, the P-T curves are beltline limited for Curves A, B, and C, for 25 and 38 EFPY. For 25 EFPY, Curve A is beltline limited above 640 psig; Curve B and Curve C are beltline limited above 500 psig. For 38 EFPY, Curve A is beltline limited above 570 psig; Curve B and Curve C are beltline limited above 410 psig and 420 psig, respectively. For Curve C, the upper vessel and beltline regions are bounding at pressures up to 50 psig. For pressures between 60 psig and 312.5 psig, the upper vessel is bounding; this is true for both 25 and 38 EFPY.

The N16 WLI nozzle is a partial penetration design similar to that shown in Figure 1 in Appendix J of the LTR, fabricated with a [[ ]]. Reference to this status is contained in the BFNP UFSAR. Therefore, the evaluation is performed, consistent with the statement in Appendix J, [[ ]]. Appendix J of the LTR provides detailed results of an analysis performed for the WLI nozzle that provides the [[ ]] a specific curve applicable for the WLI nozzle to ensure that this location is bounded in the P-T curves. The nozzle curve [[ ]] for BFNP Unit 1 Curves A, B, or C. Sample calculations are provided in Appendix D.

6.0 References

6.1 Letter, Herbert N Berkow (NRC) to George B. Stramback (GE), *Final Safety Evaluation Regarding Removal of Methodology Limitations for NEDC-32983P-A, General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation (TAC NO. MC3788)*, November 17, 2005.

6.2 Letter, Thomas B. Blount (NRC) to Doug Coleman (BWROG), *Final Safety Evaluation for Boiling Water Reactors Owners' Group Licensing Topical Report NEDC-33178P, General Electric Methodology for Development of Reactor Pressure Vessel Pressure-Temperature Curves (TAC NO. MD2693)*, April 27, 2009.

6.3 *BWR Vessel and Internals Project Integrated Surveillance Program (ISP) Data Source Book and Plant Evaluations*, BWRVIP-135, Revision 2, Electric Power Research Institute, Palo Alto, CA, October 2009 (EPRI Proprietary).

6.4 *BWR Vessel and Internals Project, Updated BWR Integrated Surveillance Program (ISP) Implementation Plan*, BWRVIP-86, Revision 1, EPRI, Palo Alto, CA: September 2008. 1016575. (EPRI Proprietary).

6.5 Letter 2013-050, Bob Carter (EPRI) to Victor Schiavone (TVA), *Evaluation of the Browns Ferry Unit 2 120° Surveillance Capsule Data*, EPRI, Palo Alto, CA, April 10, 2013 (EPRI Proprietary).

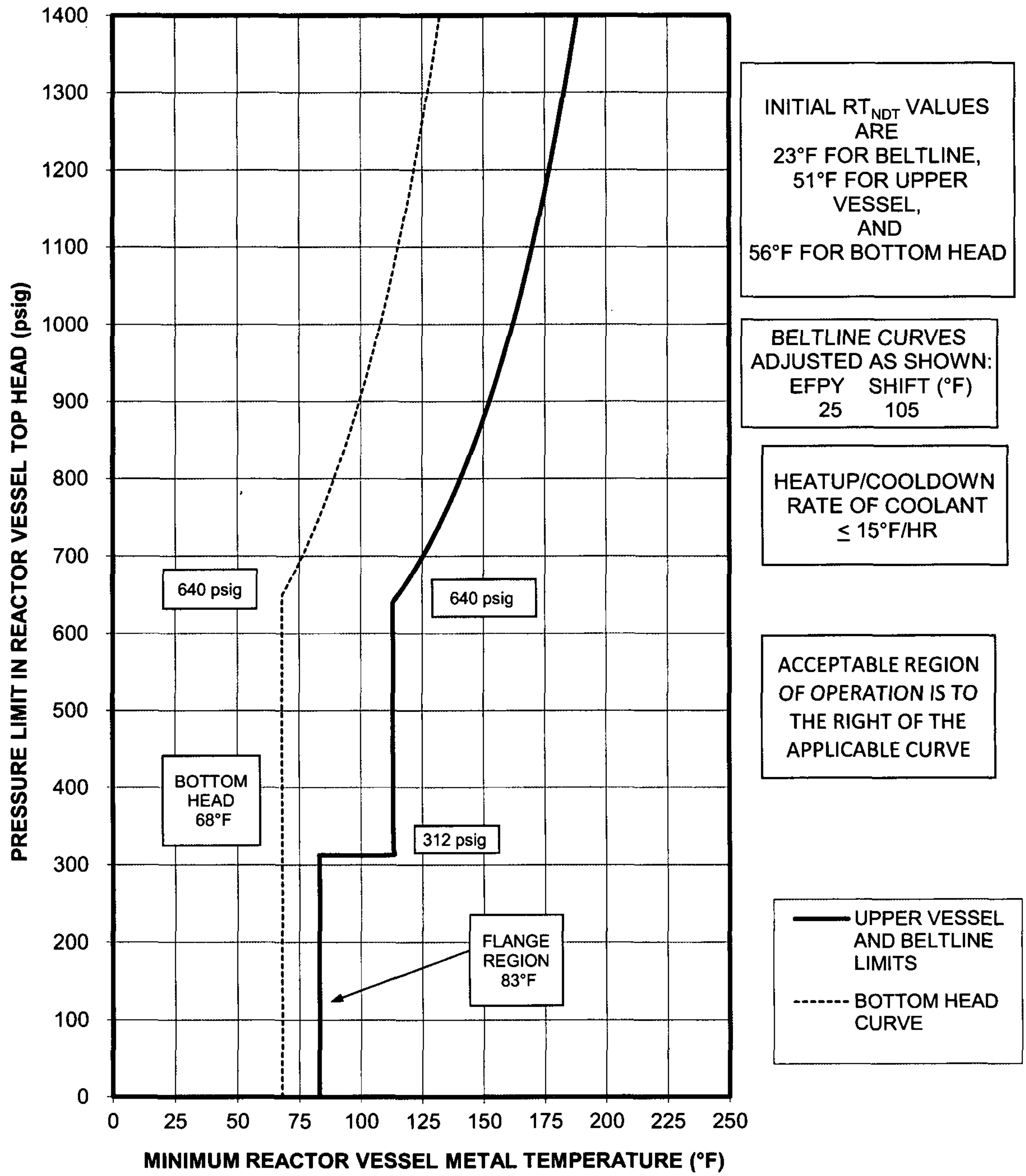


Figure 1: BFNP Unit 1 Composite Curve A Pressure Test P-T Curves Effective for Up to 25 EFPY

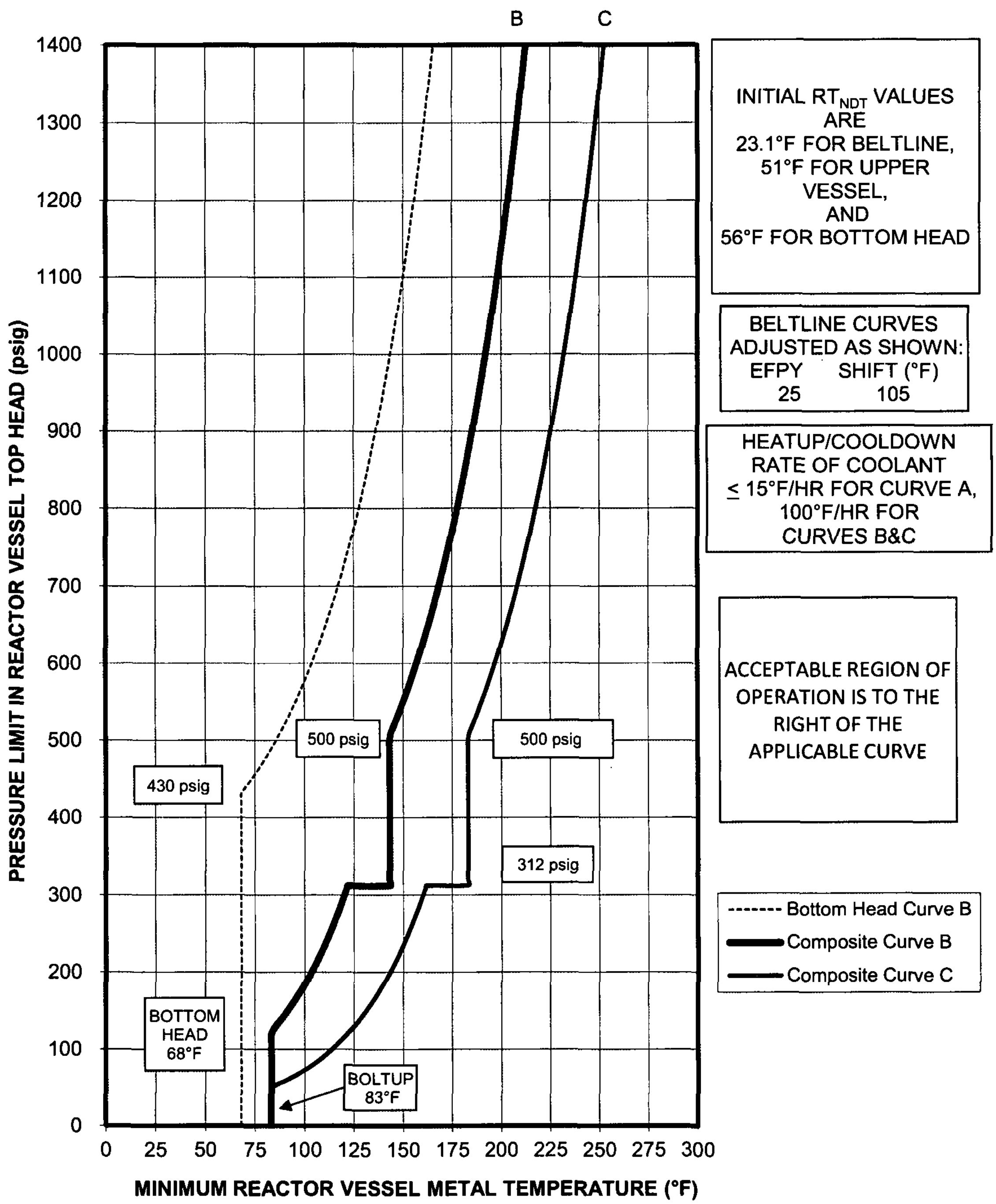


Figure 2: BFNP Unit 1 Composite Curve B Core Not Critical Including Bottom Head and Curve C Core Critical P-T Curves Effective for Up to 25 EFPY

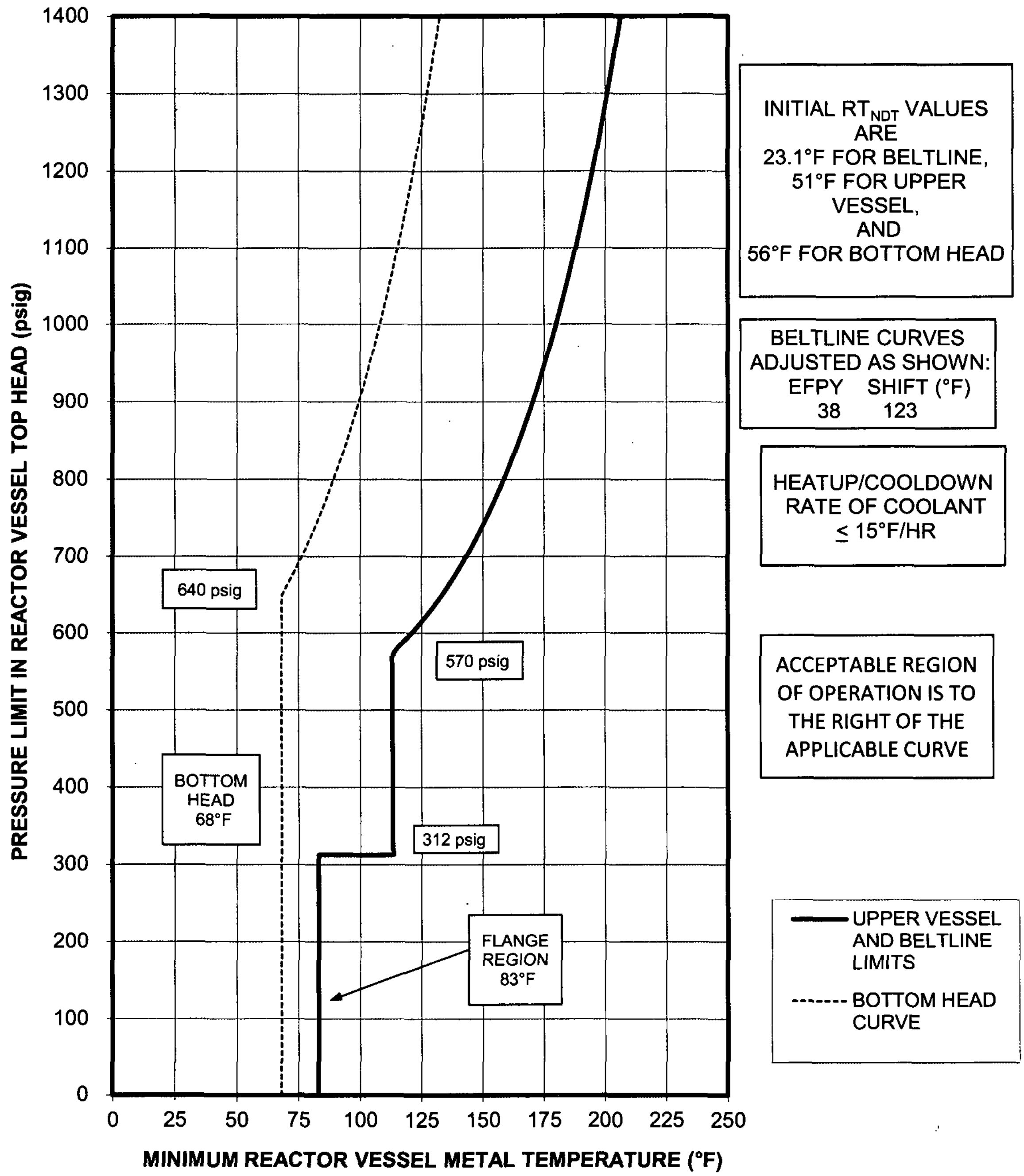


Figure 3: BFNP Unit 1 Composite Curve A Pressure Test P-T Curves Effective for Up to 38 EFPY

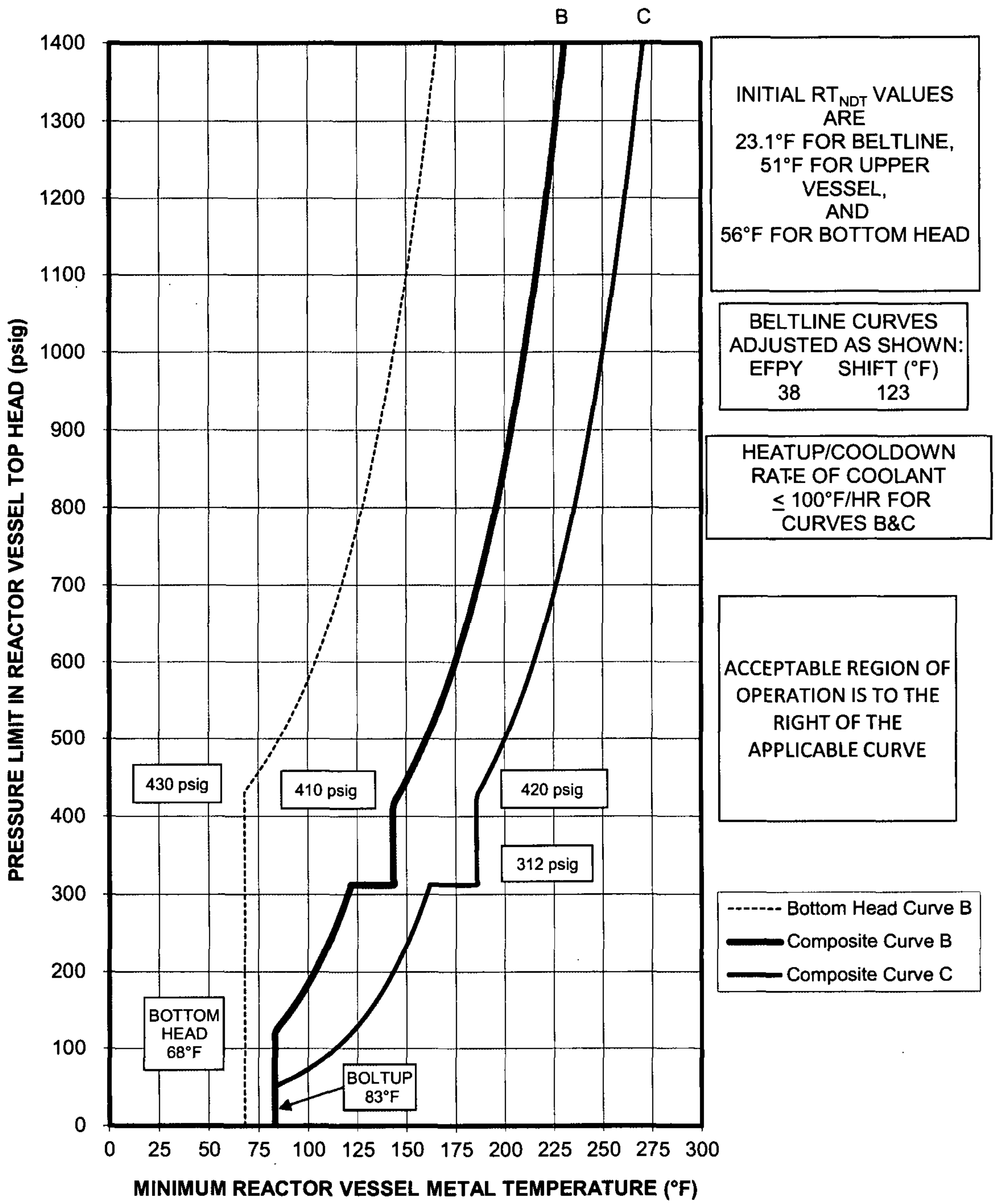


Figure 4: BFNP Unit 1 Composite Curve B Core Not Critical Including Bottom Head and Curve C Core Critical P-T Curves Effective for Up to 38 EFPY

Table 1: BFNP Unit 1 Tabulation of Curves – 25 EFPY

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE B (°F)	LIMITING 25 EFPY CURVE C (°F)
0	68.0	83.1	68.0	83.1	83.1
10	68.0	83.1	68.0	83.1	83.1
20	68.0	83.1	68.0	83.1	83.1
30	68.0	83.1	68.0	83.1	83.1
40	68.0	83.1	68.0	83.1	83.1
50	68.0	83.1	68.0	83.1	83.1
60	68.0	83.1	68.0	83.1	91.0
70	68.0	83.1	68.0	83.1	98.2
80	68.0	83.1	68.0	83.1	104.2
90	68.0	83.1	68.0	83.1	109.3
100	68.0	83.1	68.0	83.1	113.8
110	68.0	83.1	68.0	83.1	117.9
120	68.0	83.1	68.0	83.1	121.7
130	68.0	83.1	68.0	85.2	125.2
140	68.0	83.1	68.0	88.4	128.4
150	68.0	83.1	68.0	91.2	131.2
160	68.0	83.1	68.0	93.9	133.9
170	68.0	83.1	68.0	96.5	136.5
180	68.0	83.1	68.0	98.9	138.9
190	68.0	83.1	68.0	101.2	141.2
200	68.0	83.1	68.0	103.3	143.3
210	68.0	83.1	68.0	105.3	145.3
220	68.0	83.1	68.0	107.3	147.3
230	68.0	83.1	68.0	109.1	149.1
240	68.0	83.1	68.0	110.9	150.9
250	68.0	83.1	68.0	112.6	152.6
260	68.0	83.1	68.0	114.2	154.2
270	68.0	83.1	68.0	115.8	155.8
280	68.0	83.1	68.0	117.3	157.3
290	68.0	83.1	68.0	118.8	158.8
300	68.0	83.1	68.0	120.2	160.2
310	68.0	83.1	68.0	121.5	161.5
312.5	68.0	83.1	68.0	121.9	161.9
312.5	68.0	113.1	68.0	143.1	183.1

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE B (°F)	LIMITING 25 EFPY CURVE C (°F)
320	68.0	113.1	68.0	143.1	183.1
330	68.0	113.1	68.0	143.1	183.1
340	68.0	113.1	68.0	143.1	183.1
350	68.0	113.1	68.0	143.1	183.1
360	68.0	113.1	68.0	143.1	183.1
370	68.0	113.1	68.0	143.1	183.1
380	68.0	113.1	68.0	143.1	183.1
390	68.0	113.1	68.0	143.1	183.1
400	68.0	113.1	68.0	143.1	183.1
410	68.0	113.1	68.0	143.1	183.1
420	68.0	113.1	68.0	143.1	183.1
430	68.0	113.1	68.0	143.1	183.1
440	68.0	113.1	70.4	143.1	183.1
450	68.0	113.1	73.3	143.1	183.1
460	68.0	113.1	76.0	143.1	183.1
470	68.0	113.1	78.6	143.1	183.1
480	68.0	113.1	81.1	143.1	183.1
490	68.0	113.1	83.4	143.1	183.1
500	68.0	113.1	85.6	143.1	183.1
510	68.0	113.1	87.8	143.8	183.8
520	68.0	113.1	89.8	145.5	185.5
530	68.0	113.1	91.8	147.0	187.0
540	68.0	113.1	93.7	148.6	188.6
550	68.0	113.1	95.5	150.1	190.1
560	68.0	113.1	97.3	151.5	191.5
570	68.0	113.1	99.0	152.9	192.9
580	68.0	113.1	100.6	154.3	194.3
590	68.0	113.1	102.2	155.6	195.6
600	68.0	113.1	103.8	156.9	196.9
610	68.0	113.1	105.3	158.1	198.1
620	68.0	113.1	106.7	159.4	199.4
630	68.0	113.1	108.1	160.6	200.6
640	68.0	113.1	109.5	161.7	201.7
650	68.2	115.3	110.8	162.9	202.9
660	69.9	117.4	112.1	164.0	204.0

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE B (°F)	LIMITING 25 EFPY CURVE C (°F)
670	71.6	119.5	113.4	165.1	205.1
680	73.2	121.5	114.7	166.2	206.2
690	74.7	123.4	115.9	167.2	207.2
700	76.2	125.2	117.0	168.2	208.2
710	77.7	127.0	118.2	169.2	209.2
720	79.1	128.7	119.3	170.2	210.2
730	80.5	130.3	120.4	171.2	211.2
740	81.8	131.9	121.5	172.1	212.1
750	83.1	133.5	122.6	173.1	213.1
760	84.4	135.0	123.6	174.0	214.0
770	85.6	136.5	124.6	174.9	214.9
780	86.8	137.9	125.6	175.8	215.8
790	88.0	139.3	126.6	176.6	216.6
800	89.2	140.6	127.5	177.5	217.5
810	90.3	141.9	128.5	178.3	218.3
820	91.4	143.2	129.4	179.2	219.2
830	92.5	144.4	130.3	180.0	220.0
840	93.5	145.6	131.2	180.8	220.8
850	94.6	146.8	132.0	181.5	221.5
860	95.6	148.0	132.9	182.3	222.3
870	96.6	149.1	133.7	183.1	223.1
880	97.5	150.2	134.6	183.8	223.8
890	98.5	151.3	135.4	184.6	224.6
900	99.4	152.4	136.2	185.3	225.3
910	100.4	153.4	137.0	186.0	226.0
920	101.3	154.4	137.7	186.7	226.7
930	102.1	155.4	138.5	187.4	227.4
940	103.0	156.4	139.3	188.1	228.1
950	103.9	157.3	140.0	188.8	228.8
960	104.7	158.3	140.7	189.5	229.5
970	105.6	159.2	141.5	190.1	230.1
980	106.4	160.1	142.2	190.8	230.8
990	107.2	161.0	142.9	191.4	231.4
1000	108.0	161.9	143.6	192.0	232.0
1010	108.7	162.7	144.2	192.7	232.7

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE B (°F)	LIMITING 25 EFPY CURVE C (°F)
1015	109.1	163.1	144.6	193.0	233.0
1020	109.5	163.6	144.9	193.3	233.3
1030	110.3	164.4	145.6	193.9	233.9
1035	110.6	164.8	145.9	194.2	234.2
1040	111.0	165.2	146.2	194.5	234.5
1050	111.7	166.0	146.9	195.1	235.1
1055	112.1	166.4	147.2	195.4	235.4
1060	112.4	166.8	147.5	195.7	235.7
1070	113.2	167.6	148.1	196.3	236.3
1080	113.9	168.4	148.8	196.9	236.9
1090	114.6	169.1	149.4	197.4	237.4
1100	115.2	169.9	150.0	198.0	238.0
1105	115.6	170.2	150.3	198.3	238.3
1110	115.9	170.6	150.6	198.6	238.6
1120	116.6	171.3	151.2	199.1	239.1
1130	117.2	172.0	151.8	199.6	239.6
1140	117.9	172.7	152.3	200.2	240.2
1150	118.5	173.4	152.9	200.7	240.7
1160	119.1	174.1	153.5	201.2	241.2
1170	119.8	174.8	154.0	201.8	241.8
1180	120.4	175.4	154.6	202.3	242.3
1190	121.0	176.1	155.1	202.8	242.8
1200	121.6	176.7	155.7	203.3	243.3
1210	122.2	177.4	156.2	203.8	243.8
1220	122.8	178.0	156.8	204.3	244.3
1230	123.3	178.6	157.3	204.8	244.8
1240	123.9	179.2	157.8	205.3	245.3
1250	124.5	179.9	158.3	205.8	245.8
1260	125.0	180.5	158.8	206.2	246.2
1270	125.6	181.0	159.3	206.7	246.7
1280	126.1	181.6	159.8	207.2	247.2
1290	126.7	182.2	160.3	207.6	247.6
1300	127.2	182.8	160.8	208.1	248.1
1310	127.7	183.4	161.3	208.6	248.6
1320	128.3	183.9	161.8	209.0	249.0

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 25 EFPY CURVE B (°F)	LIMITING 25 EFPY CURVE C (°F)
1330	128.8	184.5	162.2	209.5	249.5
1340	129.3	185.0	162.7	209.9	249.9
1350	129.8	185.6	163.2	210.3	250.3
1360	130.3	186.1	163.6	210.8	250.8
1370	130.8	186.6	164.1	211.2	251.2
1380	131.3	187.1	164.5	211.6	251.6
1390	131.8	187.7	165.0	212.1	252.1
1400	132.3	188.2	165.4	212.5	252.5

Table 2: BFNP Unit 1 Tabulation of Curves – 38 EFPY

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE B (°F)	LIMITING 38 EFPY CURVE C (°F)
0	68.0	83.1	68.0	83.1	83.1
10	68.0	83.1	68.0	83.1	83.1
20	68.0	83.1	68.0	83.1	83.1
30	68.0	83.1	68.0	83.1	83.1
40	68.0	83.1	68.0	83.1	83.1
50	68.0	83.1	68.0	83.1	83.1
60	68.0	83.1	68.0	83.1	91.0
70	68.0	83.1	68.0	83.1	98.2
80	68.0	83.1	68.0	83.1	104.2
90	68.0	83.1	68.0	83.1	109.3
100	68.0	83.1	68.0	83.1	113.8
110	68.0	83.1	68.0	83.1	117.9
120	68.0	83.1	68.0	83.1	121.7
130	68.0	83.1	68.0	85.2	125.2
140	68.0	83.1	68.0	88.4	128.4
150	68.0	83.1	68.0	91.2	131.2
160	68.0	83.1	68.0	93.9	133.9
170	68.0	83.1	68.0	96.5	136.5
180	68.0	83.1	68.0	98.9	138.9
190	68.0	83.1	68.0	101.2	141.2
200	68.0	83.1	68.0	103.3	143.3
210	68.0	83.1	68.0	105.3	145.3
220	68.0	83.1	68.0	107.3	147.3
230	68.0	83.1	68.0	109.1	149.1
240	68.0	83.1	68.0	110.9	150.9
250	68.0	83.1	68.0	112.6	152.6
260	68.0	83.1	68.0	114.2	154.2
270	68.0	83.1	68.0	115.8	155.8
280	68.0	83.1	68.0	117.3	157.3
290	68.0	83.1	68.0	118.8	158.8
300	68.0	83.1	68.0	120.2	160.2
310	68.0	83.1	68.0	121.5	161.5
312.5	68.0	83.1	68.0	121.9	161.9

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE B (°F)	LIMITING 38 EFPY CURVE C (°F)
312.5	68.0	113.1	68.0	143.1	185.6
320	68.0	113.1	68.0	143.1	185.6
330	68.0	113.1	68.0	143.1	185.6
340	68.0	113.1	68.0	143.1	185.6
350	68.0	113.1	68.0	143.1	185.6
360	68.0	113.1	68.0	143.1	185.6
370	68.0	113.1	68.0	143.1	185.6
380	68.0	113.1	68.0	143.1	185.6
390	68.0	113.1	68.0	143.1	185.6
400	68.0	113.1	68.0	143.1	185.6
410	68.0	113.1	68.0	143.1	185.6
420	68.0	113.1	68.0	144.1	185.6
430	68.0	113.1	68.0	146.4	186.4
440	68.0	113.1	70.4	148.6	188.6
450	68.0	113.1	73.3	150.8	190.8
460	68.0	113.1	76.0	152.8	192.8
470	68.0	113.1	78.6	154.7	194.7
480	68.0	113.1	81.1	156.6	196.6
490	68.0	113.1	83.4	158.4	198.4
500	68.0	113.1	85.6	160.2	200.2
510	68.0	113.1	87.8	161.8	201.8
520	68.0	113.1	89.8	163.5	203.5
530	68.0	113.1	91.8	165.0	205.0
540	68.0	113.1	93.7	166.6	206.6
550	68.0	113.1	95.5	168.1	208.1
560	68.0	113.1	97.3	169.5	209.5
570	68.0	113.1	99.0	170.9	210.9
580	68.0	114.9	100.6	172.3	212.3
590	68.0	118.0	102.2	173.6	213.6
600	68.0	120.9	103.8	174.9	214.9
610	68.0	123.6	105.3	176.1	216.1
620	68.0	126.2	106.7	177.4	217.4
630	68.0	128.7	108.1	178.6	218.6
640	68.0	131.0	109.5	179.7	219.7
650	68.2	133.3	110.8	180.9	220.9

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE B (°F)	LIMITING 38 EFPY CURVE C (°F)
660	69.9	135.4	112.1	182.0	222.0
670	71.6	137.5	113.4	183.1	223.1
680	73.2	139.5	114.7	184.2	224.2
690	74.7	141.4	115.9	185.2	225.2
700	76.2	143.2	117.0	186.2	226.2
710	77.7	145.0	118.2	187.2	227.2
720	79.1	146.7	119.3	188.2	228.2
730	80.5	148.3	120.4	189.2	229.2
740	81.8	149.9	121.5	190.1	230.1
750	83.1	151.5	122.6	191.1	231.1
760	84.4	153.0	123.6	192.0	232.0
770	85.6	154.5	124.6	192.9	232.9
780	86.8	155.9	125.6	193.8	233.8
790	88.0	157.3	126.6	194.6	234.6
800	89.2	158.6	127.5	195.5	235.5
810	90.3	159.9	128.5	196.3	236.3
820	91.4	161.2	129.4	197.2	237.2
830	92.5	162.4	130.3	198.0	238.0
840	93.5	163.6	131.2	198.8	238.8
850	94.6	164.8	132.0	199.5	239.5
860	95.6	166.0	132.9	200.3	240.3
870	96.6	167.1	133.7	201.1	241.1
880	97.5	168.2	134.6	201.8	241.8
890	98.5	169.3	135.4	202.6	242.6
900	99.4	170.4	136.2	203.3	243.3
910	100.4	171.4	137.0	204.0	244.0
920	101.3	172.4	137.7	204.7	244.7
930	102.1	173.4	138.5	205.4	245.4
940	103.0	174.4	139.3	206.1	246.1
950	103.9	175.3	140.0	206.8	246.8
960	104.7	176.3	140.7	207.5	247.5
970	105.6	177.2	141.5	208.1	248.1
980	106.4	178.1	142.2	208.8	248.8
990	107.2	179.0	142.9	209.4	249.4
1000	108.0	179.9	143.6	210.0	250.0

PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE B (°F)	LIMITING 38 EFPY CURVE C (°F)
1010	108.7	180.7	144.2	210.7	250.7
1015	109.1	181.1	144.6	211.0	251.0
1020	109.5	181.6	144.9	211.3	251.3
1030	110.3	182.4	145.6	211.9	251.9
1035	110.6	182.8	145.9	212.2	252.2
1040	111.0	183.2	146.2	212.5	252.5
1050	111.7	184.0	146.9	213.1	253.1
1055	112.1	184.4	147.2	213.4	253.4
1060	112.4	184.8	147.5	213.7	253.7
1070	113.2	185.6	148.1	214.3	254.3
1080	113.9	186.4	148.8	214.9	254.9
1090	114.6	187.1	149.4	215.4	255.4
1100	115.2	187.9	150.0	216.0	256.0
1105	115.6	188.2	150.3	216.3	256.3
1110	115.9	188.6	150.6	216.6	256.6
1120	116.6	189.3	151.2	217.1	257.1
1130	117.2	190.0	151.8	217.6	257.6
1140	117.9	190.7	152.3	218.2	258.2
1150	118.5	191.4	152.9	218.7	258.7
1160	119.1	192.1	153.5	219.2	259.2
1170	119.8	192.8	154.0	219.8	259.8
1180	120.4	193.4	154.6	220.3	260.3
1190	121.0	194.1	155.1	220.8	260.8
1200	121.6	194.7	155.7	221.3	261.3
1210	122.2	195.4	156.2	221.8	261.8
1220	122.8	196.0	156.8	222.3	262.3
1230	123.3	196.6	157.3	222.8	262.8
1240	123.9	197.2	157.8	223.3	263.3
1250	124.5	197.9	158.3	223.8	263.8
1260	125.0	198.5	158.8	224.2	264.2
1270	125.6	199.0	159.3	224.7	264.7
1280	126.1	199.6	159.8	225.2	265.2
1290	126.7	200.2	160.3	225.6	265.6
1300	127.2	200.8	160.8	226.1	266.1
1310	127.7	201.4	161.3	226.6	266.6

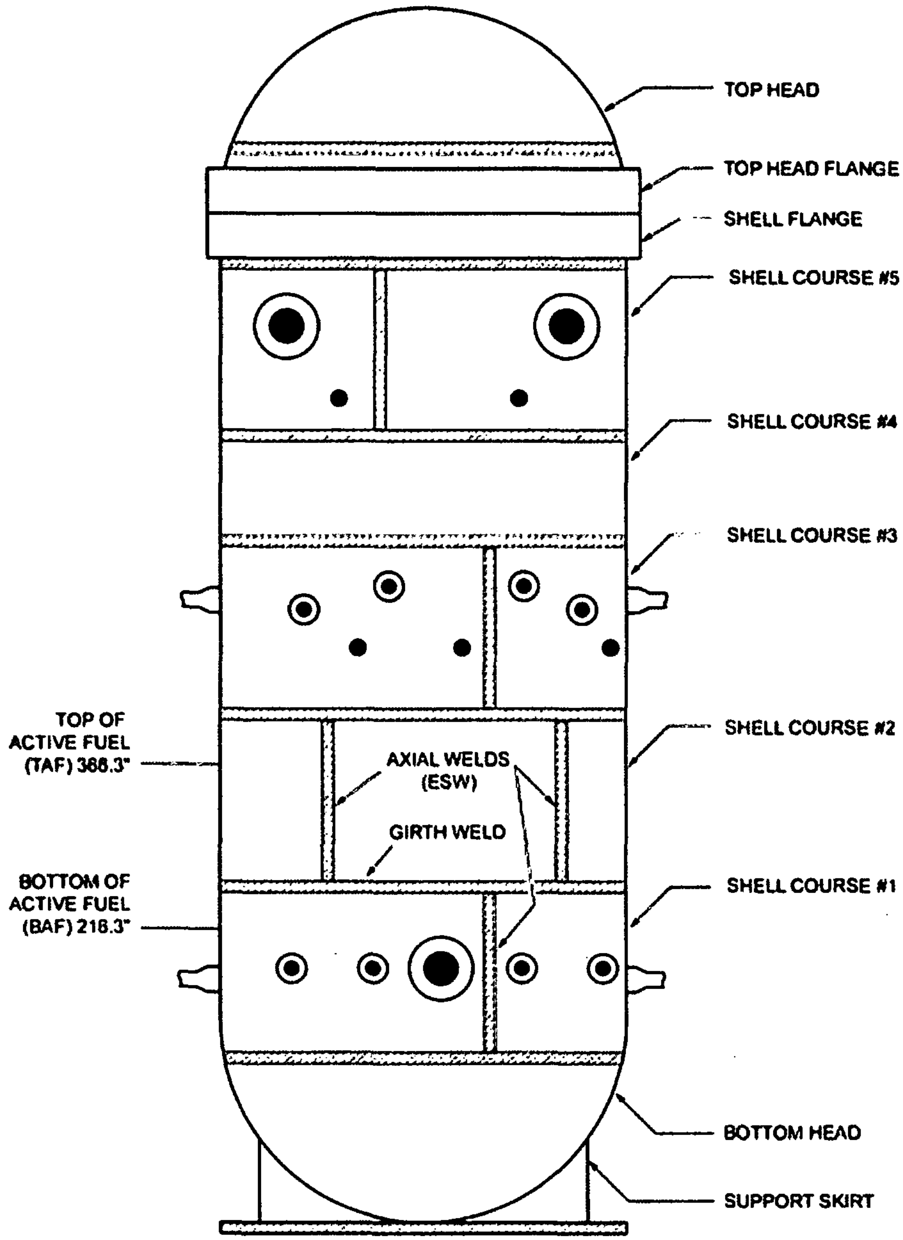
PRESSURE (PSIG)	BOTTOM HEAD CURVE A (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE A (°F)	BOTTOM HEAD CURVE B (°F)	UPPER RPV & BELTLINE AT 38 EFPY CURVE B (°F)	LIMITING 38 EFPY CURVE C (°F)
1320	128.3	201.9	161.8	227.0	267.0
1330	128.8	202.5	162.2	227.5	267.5
1340	129.3	203.0	162.7	227.9	267.9
1350	129.8	203.6	163.2	228.3	268.3
1360	130.3	204.1	163.6	228.8	268.8
1370	130.8	204.6	164.1	229.2	269.2
1380	131.3	205.1	164.5	229.6	269.6
1390	131.8	205.7	165.0	230.1	270.1
1400	132.3	206.2	165.4	230.5	270.5

Appendix A
Reactor Vessel Material Surveillance Program

None of the BFNP Unit 1 surveillance capsules have been removed from the reactor vessel. All three capsules have been in the reactor vessel since plant startup.

As described in the BFNP Unit 1 UFSAR Section 4.2.6, Inspection and Testing, the BWRVIP ISP will determine the removal schedule for the remaining BFNP Unit 1 surveillance capsules. The BFNP Unit 1 material surveillance program is administered in accordance with the BWRVIP ISP. The ISP combines the United States (US) BWR surveillance programs into a single integrated program. This program uses similar heats of materials in the surveillance programs of BWRs to represent the limiting materials in other vessels. It also adds data from the BWR SSP. Per the BWRVIP ISP, BFNP Unit 1 is not a host plant; all surveillance capsules are classified as "Deferred".

Appendix B
BFNP Unit 1 Reactor Pressure Vessel P-T Curve Supporting Plant-Specific Information



Note: The WLI nozzle centerline is at 366" elevation, at the top of active fuel.

Figure B-1: BFNP Unit 1 Reactor Pressure Vessel

Table B-1: BFNP Unit 1 Initial RT_{NDT} Values for RPV Plate and Flange Materials

Component	Heat	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{50T}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
PLATES & FORGINGS:								
Top Head & Flange								
Shell Flange (MK48)								
48-127-1	ALU 55	10	118	90	79	-20	10	10
Top Head Flange (MK209)								
209-127-1	AMW 56	10	120	109	126	-20	10	10
Top Head Dollar (MK201)								
201-122-2	C-1354-3	40	67	58	51	10	Not Available	40
Top Head Side Plates (MK202)								
202-122-1	A0057-2	10	45	41	55	-2	10	10
202-122-2	A0057-2	10	37	30	42	20	10	20
202-122-5	C1182-1	10	41	60	50	-2	10	10
202-122-6	C1182-1	10	57	45	62	-10	10	10
202-139-5	C2737-2	10	68	90	86	-20	10	10
202-139-6	C2737-2	10	84	78	86	-20	10	10
Shell Courses								
Upper Shell Plates (MK60)								
6-127-7	A0973-1	10	57	60	41	-2	10	10
6-127-12	C1942-2	10	46	52	52	-12	10	10
6-127-19	C2496-2	10	56	58	54	-20	10	10
Transition Shell Plates (MK16)								
15-127-2	C-2533-2	10	53	48	43	-6	10	10
15-127-5	A-0954-3	10	46	40	32	16	10	16
15-127-6	A-0954-3	10	41	52	45	-2	10	10
Upper Intermediate Shell Plates (MK59)								
6-127-3	B5842-1	10	63	62	61	-20	10	10
6-127-8	A0954-1	10	52	60	55	-20	10	10
6-127-10	B5853-2	10	70	65	66	-20	10	10
Lower Intermediate Shell Plates (MK58)								
6-139-19	C2884-2	10	33	55	34	14	0	14
6-139-20	C2868-2	10	46	55	25	30	0	30
6-139-21	C2753-1	10	39	58	57	2	-20	2
Lower Shell Segments (MK57)								
6-127-2	B5864-1	10	84	73	62	-20	-20	-20
6-127-4	A1009-1	10	62	84	77	-20	-10	-10
6-127-1	A0999-1	10	56	59	66	-20	-20	-20
Bottom Head								
Bottom Head Upper Torus (MK2)								
2-122-7	B5924-1	40	75	70	75	10	40	40
2-122-8	B5924-1	40	37	61	44	36	40	40
2-122-10	A0942-2	40	62	62	65	10	40	40
2-127-7	C2412-3	40	91	90	57	10	40	40
2-127-8	C2412-3	40	95	92	82	10	40	40
2-127-9	C2393-2	40	105	125	112	10	40	40
Bottom Head Lower Torus (MK4)								
4-122-5	A0927-2	40	71	50	59	10	40	40
4-122-6	A0927-2	40	75	66	64	10	40	40
4-122-7	C1412-3	40	30	41	40	50	40	50
4-122-8	C1412-3	40	27	35	49	56	40	56
Bottom Head Dollar (MK1)								
1-122-2	B5861-1	40	45	50	49	20	40	40

Note: *Minimum Charpy values are provided for all materials.*

Table B-2: BFNP Unit 1 Initial RT_{NDT} Values for RPV Nozzle and Weld Materials

Component	Heat or Heat/Flux/Lot	Test Temp (°F)	Charpy Energy (ft-lb)			$(T_{50T}-60)$ (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Nozzles:								
N1 Recirc Outlet Nozzle (MK8)								
8-127-1	E31VW 431H-1	40	109	86	90	10	40	40
8-139-2	AV1696 7J-6327	40	34	46	44	42	40	42
N2 Recirc Inlet Nozzle (MK7)								
7-122-1	ZT2872 9709-1	40	65	54	58	10	30	30
7-122-7	ZT2869 9704-1	40	31	38	39	48	30	48
7-127-9	E25VW 433H-9	40	93	103	110	10	40	40
7-122-10	ZT2872 9709-2	40	65	54	58	10	30	30
7-122-11	ZT2885 9711-1	40	34	37	41	42	30	42
7-122-12	ZT2885 9711-2	40	34	37	41	42	30	42
7-122-13	ZT2885-3 9710-2	40	64	48	36	39	30	39
7-122-16	ZT-2885	40	38	38	48	35	30	35
7-122-18	ZT2885 9712-2	40	54	52	49	12	30	30
7-122-19	ZT2869 9705-1	40	69	53	42	27	30	30
N3 Steam Outlet Nozzle (MK14)								
14-127-1	E26VW 435H-1	40	97	77	94	10	40	40
14-127-2	E26VW 435H-2	40	86	84	76	10	40	40
14-127-3	E26VW 435H-3	40	102	92	105	10	40	40
14-127-4	E26VW 435H-4	40	119	94	94	10	40	40
N4 Feedwater Nozzle (MK10)								
10-127-1	E25VW 436H-1	40	98	97	92	10	40	40
10-127-2	E25VW 436H-2	40	124	98	105	10	40	40
10-127-3	E25VW 436H-3	40	99	84	92	10	40	40
10-127-4	E25VW 436H-4	40	111	98	101	10	40	40
10-127-5	E25VW 436H-5	40	114	114	110	10	40	40
10-127-6	E25VW 436H-6	40	117	111	112	10	40	40
N5 Core Spray Nozzle (MK11)								
11-111-1	BT2001-2 7098	40	48	32	42	46	40	46
11-111-2	BT2001-3 6945-1	40	54	36	49	38	40	40
N6 Top Head Instrumentation Nozzle (MK206) 206-139-1 & -4	BT2615-4	40	123	143	144	10	40	40
N7 Vent Nozzle (MK204) 204-127-1	ZT3043-3	40	102	130	117	10	40	40
N8 Jet Pump Instr. Nozzle (MK19) 19-127-1 & -2	ZT3043	40	107	112	113	10	40	40
N9 CRD HYD System Return Nozzle (MK13) 13-145-1	EV9793 7K-6233A	40	81	50	91	10	40	40
N10 Core DP & Liquid Control Nozzle (MK17) 17-127-1	ZT3043	40	106	136	111	-20	40	40
N11, N12, N16 Instrumentation Nozzle (MK12) 12-127-1 through 6	Inconel 8564							
N13, N14 High & Low Pressure Seal Leak (MK139) 139-127-1 & -2	Not Available						40	40*
N15 Drain Nozzle (MK22) 22-127-1	213099	40	42	44	39	32	40	40
WELDS: *Cylindrical Shell Axial Welds* Electroslag Welds	ESW							23.1**
Girth Welds Shell 1 to Shell 2 WF 154 (SAW)	406L44, Lot 8720							20**

Notes: Minimum Charpy values are provided for all materials.

* No Nil Ductility Transition (NDT) value is available on the CMTR; obtained from the purchase specification.

** Weld initial RT_{NDT} values were obtained from previously-approved submittals.

Table B-3: BFNP Unit 1 Initial RT_{NDT} Values for RPV Appurtenance and Bolting Materials

Component	Heat	Test Temp (°F)	Charpy Energy (ft-lb)			$(T_{50T}-60)$ (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Miscellaneous Appurtenances: Support Skit Segment (MK24) 24-139-1 through -4	C3888-5	10	38	40	41	4	40	40
Shroud Support (MK51, MK52, MK53)	Alloy 600							
Steam Dryer Support Bracket (MK131) 131-127-1 through -4	Stainless Steel 00431							
Core Spray Bracket (MK132) 132-127-1 through -8	Stainless Steel 3342230							
Dryer Hold Down Bracket (MK133) 133-127-1 through -4	EV-8446	40	38	42	37	36	40	40
Guide Rod Bracket (MK134) 134-127-1 & -2	Stainless Steel 139506							
Feedwater Sparger Brackets (MK135) 135-127-1 through -12	Stainless Steel 00431							
Stabilizer Bracket (MK196) 196-127-5 through -12	C6458-1	10	60	59	56	-20	40	40
Surveillance Brackets (MK199 & MK200) 199-127-1 through -3 200-127-1 through -3	Stainless Steel 342633-2 342633-2							
Lift Lugs (MK210) 210-122-1, -2, -3, & -6	A1210-3B	10	83	98	95	-20	40	40
CRD Penetrations (MK101-MK128) 101 through 128	Alloy 600							
Refueling Containment Skirt (MK71) 71-127-1 through -4	B7478-4B							40*

Component	Heat	Test Temp (°F)	Charpy Energy (ft-lb)			Lateral Expansion (mils)	Lowest Service Temp (°F)
STUDS:							
Closure (MK61)	6730502	10	34	52	68	N/A	70
NUTS:							
Closure (MK62)	6730502	10	34	52	68	N/A	70
	23514	10	49	53	63	29	10
	6780382	10	45	42	46	N/A	70
	6790156	N/A	N/A	N/A	N/A	N/A	70
BUSHINGS:							
Closure (MK63)	T3798	10	61	69	73	51	10
	M2513	10	64	65	67	40	10
	M2514	10	66	56	70	42	10
	EV9474	10	67	64	62	N/A	70
	AV3107	10	63	70	72	N/A	70
WASHERS:							
Closure (MK64 and MK65)	6730502	10	34	52	68	N/A	70
	6780278	N/A	N/A	N/A	N/A	N/A	70

Notes: Minimum Charpy values are provided for all materials.
* No NDT value is available on the CMTR; obtained from the purchase specification.

Table B-4: BFNP Unit 1 Adjusted Reference Temperatures for Up to 25 EFPY

Lower-Intermediate Plates

Thickness in inches = 6.125

25 EFPY Peak I.D. fluence = 1.01E+18 n/cm^2

25 EFPY Peak ¼ T fluence = 6.99E+17 n/cm^2

Lower Plates & Lower to Lower-Intermediate Girth Weld

Thickness in inches = 6.125

25 EFPY Peak I.D. fluence = 8 14E+17 n/cm^2

25 EFPY Peak ¼ T fluence = 5.64E+17 n/cm^2

Axial Welds

Thickness in inches = 6.125

25 EFPY Peak I.D. fluence = 1.01E+18 n/cm^2

25 EFPY Peak ¼ T fluence = 6.99E+17 n/cm^2

Water Level Instrumentation Nozzle

Thickness in inches = 6.125

25 EFPY Peak I.D. fluence = 3.04E+17 n/cm^2

25 EFPY Peak ¼ T fluence = 2.11E+17 n/cm^2

Component	Heat or Heat/Lot	%Cu	%Ni	CF	Adjusted CF	Initial RT_{NDT} °F	¼ T Fluence n/cm^2	25 EFPY ¼T ΔRT_{NDT} °F	σ_I	σ_Δ	Margin °F	25 EFPY ¼ T Shift °F	25 EFPY ¼ T ART °F
PLATES:													
Lower Shell													
6-127-1	A0999-1	0.14	0.60	100		-20	5.64E+17	31	0	16	31	62	42
6-127-2	B5864-1	0.15	0.44	101		-20	5.64E+17	32	0	16	32	63	43
6-127-4	A1009-1	0.14	0.50	96		-10	5.64E+17	30	0	15	30	60	50
Lower-Intermediate Shell													
6-139-19	C2884-2	0.12	0.53	82		14	6.99E+17	28	0	14	28	57	71
6-139-20	C2868-2	0.09	0.48	58		30	6.99E+17	20	0	10	20	41	71
6-139-21	C2753-1	0.08	0.50	51		2	6.99E+17	18	0	9	18	36	38
WELDS:													
Axial Welds													
Electroslag Weld (ESW)	-	0.24	0.37	141		23.1	6.99E+17	49	13	25	56	105	128
Lower to Lower-Intermediate Girth Weld													
WF154	406L44	0.27	0.60	184		20	5.64E+17	57	10	28	59	117	137

Component	Heat or Heat/Lot	%Cu	%Ni	CF	Adjusted CF	Initial RT_{NDT} °F	¼ T Fluence n/cm²	25 EFPY ¼T ΔRT_{NDT} °F	σ_I	σ_Δ	Margin °F	25 EFPY ¼ T Shift °F	25 EFPY ¼ T ART °F
BEST ESTIMATE CHEMISTRIES:													
None	-	-	-	-		-	-	-	-	-	-	-	-
NOZZLES:													
N16 Water Level Instrumentation													
Forging	Inconel (1)	[[		]]		[[ ]]	2.11E+17	[[					]]
Weld	Inconel												
INTEGRATED SURVEILLANCE PROGRAM:													
Plate(2,3)	[[						6.99E+17	[[					
Weld(3,4)						]]	5.64E+17						]]

Notes:

(1) [[ ]]

(2) The representative plate material is not the same heat number as the target plate; therefore the RG 1.99 R2 CF is used. This information is not applicable to development of the P-T curves and is provided for information only.

(3) [[

]]

Table B-5: BFNP Unit 1 Adjusted Reference Temperatures for Up to 38 EFPY

Lower-Intermediate Plates

Thickness in inches = 6.125

38 EFPY Peak I.D. fluence = 1 58E+18 n/cm²

38 EFPY Peak ¼ T fluence = 1.09E+18 n/cm²

Lower Plates & Lower to Lower-Intermediate Girth Weld

Thickness in inches = 6.125

38 EFPY Peak I.D. fluence = 1 28E+18 n/cm²

38 EFPY Peak ¼ T fluence = 8.86E+17 n/cm²

Axial Welds

Thickness in inches = 6.125

38 EFPY Peak I.D. fluence = 1.58E+18 n/cm²

38 EFPY Peak ¼ T fluence = 1.09E+18 n/cm²

Water Level Instrumentation Nozzle

Thickness in inches = 6.125

38 EFPY Peak I.D. fluence = 4.77E+17 n/cm²

38 EFPY Peak ¼ T fluence = 3.30E+17 n/cm²

Component	Heat or Heat/Lot	%Cu	%Ni	CF	Adjusted CF	Initial RT_{NDT} °F	¼ T Fluence n/cm²	38 EFPY ¼ T ΔRT_{NDT} °F	σ_I	σ_Δ	Margin °F	38 EFPY ¼ T Shift °F	38 EFPY ¼ T ART °F
PLATES:													
Lower Shell													
6-127-1	A0999-1	0.14	0.60	100		-20	8.86E+17	39	0	17	34	73	53
6-127-2	B5864-1	0.15	0.44	101		-20	8.86E+17	40	0	17	34	74	54
6-127-4	A1009-1	0.14	0.50	96		-10	8.86E+17	38	0	17	34	72	62
Lower-Intermediate Shell													
6-139-19	C2884-2	0.12	0.53	82		14	1.09E+18	36	0	17	34	70	84
6-139-20	C2868-2	0.09	0.48	58		30	1.09E+18	25	0	13	25	50	80
6-139-21	C2753-1	0.08	0.50	51		2	1.09E+18	22	0	11	22	44	46
WELDS:													
Axial Welds													
ESW	-	0.24	0.37	141		23.1	1.09E+18	61	13	28	62	123	146
Lower to Lower-Intermediate Girth Weld													
WF154	406L44	0.27	0.60	184		20	8.86E+17	72	10	28	59	132	152

Component	Heat or Heat/Lot	%Cu	%Ni	CF	Adjusted CF	Initial RT_{NDT} °F	¼ T Fluence n/cm^2	38 EFPY ¼ T ΔRT_{NDT} °F	σ_I	σ_Δ	Margin °F	38 EFPY ¼ T Shift °F	38 EFPY ¼ T ART °F
BEST ESTIMATE CHEMISTRIES:													
None	-	-	-	-		-	-	-	-	-	-	-	-
NOZZLES:													
N16 Water Level Instrumentation													
Forging	Inconel [1]	[[		]]		[[ ]]	3.03E+17	[[					]]
Weld	Inconel												
INTEGRATED SURVEILLANCE PROGRAM:													
Plate[2,3]	[[						1.09E+18	[[					
Weld[3,4]						]]	8.86E+17						]]

Notes:

(1) [[ ]]

(2) The representative plate material is not the same heat number as the target plate; therefore the RG 1.99 R2 CF is used. This information is not applicable to development of the P-T curves and is provided for information only.

(3) [[

]]

Table B-6: BFNP Unit 1 RPV Beltline P-T Curve Input Values for 38 EFPY

Adjusted RT_{NDT} = Initial RT_{NDT} + Shift	A = 23.1 + 123 = 146.1°F (Based on ART values in Table B-5)
Vessel Height	H = 875.13 inches
Bottom of Active Fuel Height	B = 216.3 inches
Vessel Radius (to base metal)	R = 125.7 inches
Minimum Vessel Thickness (without clad)	t = 6.125 inches

Note: The ART for 25 EFPY is 128°F as shown in Table B-4.

Table B-7: BFNP Unit 1 Definition of RPV Beltline Region[1]

Component	Elevation (inches from RPV "0")
Shell # 2 - Top of Active Fuel (TAF)	366.3
Shell # 1 - Bottom of Active Fuel (BAF)	216.3
Shell # 2 – Top of Extended Beltline Region (38 EFPY)	378.3
Shell # 1 – Bottom of Extended Beltline Region (38 EFPY)	206.4
Circumferential Weld Between Shell #1 and Shell #2	258.0
Circumferential Weld Between Shell #2 and Shell #3	391.5
Centerline of Recirculation Outlet Nozzle in Shell # 1	161.5
Top of Recirculation Outlet Nozzle N1 in Shell # 1	188.0
Centerline of Recirculation Inlet Nozzle N2 in Shell # 1	181.0
Top of Recirculation Inlet Nozzle N2 in Shell # 1	193.3
Centerline of WLI Nozzle in Shell # 2	366.0
Bottom of WLI Nozzle in Shell # 2	364.6

Note:

(1) The beltline region is defined as any location where the peak neutron fluence is expected to exceed or equal 1.0e17 n/cm^2.

Based on the above, it is concluded that none of the BFNP Unit 1 reactor vessel plates, nozzles, or welds, other than those included in the ART table, are in the beltline region.

Appendix C
BFNP Unit 1 Reactor Pressure Vessel P-T Curve Checklist

Table C-1 provides a checklist that defines pertinent points of interest regarding the methods and information used in developing the BFNP Unit 1 PTLR. This table demonstrates that all important parameters have been addressed in accordance with the P-T curve LTR (Reference 6.2), and includes comments, resolutions, and clarifications as necessary.

Table C-1: BFNP Unit 1 Checklist

Parameter	Completed	Comments/Resolutions/Clarifications
Initial RT_{NDT}		
Initial RT_{NDT} has been determined for all vessel materials including plates, flanges, forgings, studs, nuts, bolts, welds. Include explanation (including methods/sources) of any exceptions, resolution of discrepant data (e.g., deviation from originally reported values).	☒	The N16 WLI nozzle is considered within the beltline region. This forging was [[ ]] are considered. All other information remains unchanged from previous submittals.
Appendix B contains tables of all initial RT_{NDT} values.	☒	
Has any non-plant-specific initial RT_{NDT} information (e.g., ISP, comparison to other plant) been used?	☒	Plate heat [[ ]] information was obtained from the ISP database. This material is [[ ]] to the target vessel plate material and, in accordance with the ISP guidance; this data was [[ ]] the limiting ART. Weld heat [[ ]] information was obtained from the ISP database. This material is [[ ]] to the target vessel weld material and, in accordance with ISP guidance, this data was [[ ]] the limiting ART.
If deviation from the P-T curve LTR process occurred, sufficient supporting information has been included (e.g., Charpy V-Notch data used to determine an Initial RT_{NDT}).	☒	No deviations from the P-T curve LTR process were applied.

Parameter	Completed	Comments/Resolutions/Clarifications
All previously published Initial RT_{NDT} values from sources such as the Generic Letter (GL) 88-01, Reactor Vessel Integrity Database (RVID), UFSAR, etc., have been reviewed.	☒	RVID was reviewed for the beltline materials; all initial RT_{NDT} values agree; no further review was performed.
Adjusted Reference Temperature		
Sigma I (σ_I, standard deviation for Initial RT_{NDT}) is 0°F unless the RT_{NDT} was obtained from a source other than CMTRs. If σ_I is not equal to 0°F, reference/basis has been provided.	☒	Sigma I is equal to 0°F for all materials except the weld heats. The ESW material uses σ_I of 13°F and the Submerged Arc Weld (SAW) girth weld material uses a σ_I of 10°F, consistent with previous NRC submittals.
Sigma σ (σ_Δ, standard deviation for ΔRT_{NDT}) is determined per RG 1.99, Revision 2	☒	
Chemistry has been determined for all vessel beltline materials including plates, forgings (if applicable), and welds. Include explanation (including methods/sources) of any exceptions, resolution of discrepant data (e.g., deviation from originally reported values).	☒	The N16 WLI nozzle is [[ ]] is considered. ISP data is obtained from BWRVIP-135, Revision 2. No deviations from previously reported values.
Non-plant-specific chemistry information (e.g., ISP, comparison to other plant) used has been adequately defined and described.	☒	Plate heat [[ ]] has been evaluated using best estimate chemistry from the ISP.
For any deviation from the P-T curve LTR process, sufficient information has been included.	☒	While not a deviation, it is noted that the limiting ART for the beltline materials is that for a weld heat. As this material [[ ]] to provide bounding P-T curves for the beltline region. No deviations from the P-T curve LTR process.

Parameter	Completed	Comments/Resolutions/Clarifications
All previously published chemistry values from sources such as the GL88-01, RVID, UFSAR, etc., have been reviewed.	☒	RVID was reviewed; all chemistry values agree; no further review was performed.
The fluence used for determination of ART and any extended beltline region was obtained using an NRC-approved methodology.	☒	
The fluence calculation provides an axial distribution to allow determination of the vessel elevations that experience fluence of 1.0e17 n/cm^2 both above and below active fuel.	☒	
The fluence calculation provides an axial distribution to allow determination of the fluence for intermediate locations such as the beltline girth weld (if applicable) or for any nozzles within the beltline region.	☒	
All materials within the elevation range where the vessel experiences a fluence ≥1.0e17 n/cm^2 have been included in the ART calculation. All initial RT_{NDT} and chemistry information is available or explained.	☒	
Discontinuities		
The discontinuity comparison has been performed as described in Section 4.3.2.1 of the P-T curve LTR. Any deviations have been explained.	☒	There are no deviations.
Discontinuities requiring additional components (such as nozzles) to be considered part of the beltline have been adequately described. It is clear which curve is used to bound each discontinuity.	☒	All discontinuities are bounded by either the Upper Vessel, Bottom Head, or Beltline curve; those bounded by the Upper Vessel and/or Bottom Head are in accordance with Tables 4-4a and 4-5a of the LTR.
Appendix G of the P-T curve LTR describes the process for considering a thickness discontinuity, both beltline and non-beltline. If there is a discontinuity in the vessel that requires such an evaluation, the evaluation was performed. The affected curve was adjusted to bound the discontinuity, if required.	☒	The thickness discontinuity evaluation demonstrates that no additional adjustment is required; the curves bound the discontinuity stresses.

Parameter	Completed	Comments/Resolutions/Clarifications
Appendix H of the P-T curve LTR defines the basis for the CRD Penetration curve discontinuity and the appropriate transient application. The plant-specific evaluation bounds the requirements of Appendix H.	☒	
Appendix J of the P-T curve LTR defines the basis for the WLI Nozzle curve discontinuity and the appropriate transient application. The plant-specific evaluation bounds the requirements of Appendix J.	☒	

Appendix D
Sample P-T Curve Calculations

Beltline Water Level Instrumentation Nozzle

Pressure Test (Curve A)

K_I for the discontinuity is determined considering the K_I obtained from Table 7 of Appendix J (for hydrotest). For 1070 psig, this K_I is [[ ]] as follows:

K_I = [[ ]]

$T\text{-}RT_{NDT}$ is calculated in the following manner:

$T\text{-}RT_{NDT}$ = [[ ]]

The ART is added to $T\text{-}RT_{NDT}$ to obtain the required T:

T = [[ ]]

This temperature is not obvious from the P-T curve as it is bounded by the [[ ]].

Core Not Critical (Curve B)

K_I for the discontinuity is determined considering the K_I obtained from Table 5 of Appendix J.

[[ ]]

The transient used for the WLI nozzle, defined in Appendix J, is used in determination of K_I.

The total K_I is therefore:

K_I = [[ ]]

$T\text{-}RT_{NDT}$ is calculated in the following manner:

$T\text{-}RT_{NDT}$ = [[ ]]

The ART is added to $T\text{-}RT_{NDT}$ to obtain the required T:

T = [[ ]]

This temperature is not obvious from the P-T curve as it is bounded by the [[ ]]

Correction Factor

The total stress for the WLI exceeds the yield stress; therefore, the correction factor, R, is calculated to consider the nonlinear effects in the plastic region according the following equation based on the assumptions and recommendation of Welding Research Council (WRC) Bulletin 175 as shown in Equation 4-7 of Reference 6.2.

$$R = [\sigma_{ys} - \sigma_{pm} + ((\sigma_{total} - \sigma_{ys})/30)]/(\sigma_{total} - \sigma_{pm})$$

Applied to the WLI:

R = [[
]]

Beltline Calculations Excluding Water Level Instrumentation Nozzle

Pressure Test (Curve A) at 1070 psig for 38 EFPY

The limiting beltline material is the bounding component for Curve A; therefore, a sample calculation for this material, not including the WLI nozzle is provided for 1070 psig.

The limiting ART applied to the beltline PT curves is [[ ]] for the [[ ]], which is also in the [[ ]]. However, the [[ ]] as defined in ASME Appendix G. When comparing the resultant required temperature to that for the axial ESW, it is seen that the axial weld will provide a more limiting curve. Therefore, the ART of 146°F is used in developing the beltline P-T curve.

Pressure is calculated to include hydrostatic pressure for a full vessel:

P = 1070 psig + (H – B)*0.0361 psi/inch

(H=vessel height; B=elevation of bottom of active fuel)

= 1070 + (875.13 – 216.3) * 0.0361

= 1093.8 psig

Pressure Stress:

σ = PR/t

(P=pressure; R=vessel radius; t=vessel thickness)

= 1.094 * 125.7 / 6.125

= 22.45 ksi

M_m = $0.926\sqrt{t}$

= $0.926\sqrt{6.125}$

= 2.29

The stress intensity factor, K_{It}, is calculated as described in Section 4.3.2.2.4 of the LTR, except that "G" is 15°F/hr instead of 100°F/hr.

M_t = 0.2914, from ASME Appendix G, Figure G-2214-1

ΔT = $GC^2 / 2\beta$

G = coolant heatup/cooldown rate of 15°F/hr

C = minimum vessel thickness including clad = 6.125"+0.1875"=6.313"=0.526 ft

β = thermal diffusivity at 550°F = 0.354 ft^2/hr

= $(15*(0.526)^2) / (2*0.354)$

= 5.86°F

K_{It} = $M_t * \Delta T$

= 0.2914 * 5.86

= 1.71

K_{Im} = $\sigma * M_m$

= 22.45 * 2.29

= 51.4

$T-RT_{NDT}$ = $\ln[(1.5*K_{Im} + K_{It} - 33.2)/20.734]/0.02$

= $\ln[(1.5*51.4 + 1.71 - 33.2)/20.734]/0.02$

= 39.4°F

T is calculated by adding the ART:

T = 39.4 + 146

= 185.4°F for P = 1070 psig at 38 EFPY

This temperature represents the limiting point on Curve A and is cited as 185.6°F in Table 2.

Core Not Critical (Curve B) at 1070 psig for 38 EFPY

The WLI nozzle is not the bounding component at any point in the pressure range; therefore, a sample calculation for the limiting beltline material, which bounds the WLI nozzle, is provided for 1070 psig.

As discussed above and in Section 5.0 and Table B-5, the limiting ART applied to the beltline Curve B is 146°F for the axial ESW.

The ΔT term is calculated as shown above for the Pressure Test case, but the temperature rate change is 100°F/hr instead of 15°F/hr. Therefore, ΔT equals 39°F.

P = 1070 psig + (H – B)*0.0361 psi/inch

(H=vessel height; B=elevation of bottom of active fuel)

= 1070 + (875.13 – 216.3) * 0.0361

= 1093.8 psig

Pressure Stress:

σ = PR/t

(P=pressure; R=vessel radius; t=vessel thickness)

= 1.094 * 125.7 / 6.125

= 22.45 ksi

K_{Im} = $\sigma * M_m$

= 22.45 * 2.29

= 51.41

K_{It} = M_t * ΔT (for the 100°F/hr case)

= 0.2914 * 39

= 11.36

$T-RT_{NDT}$ = ln[(2.0*K_{Im} + K_{It} – 33.2)/20.734]/0.02

= ln[(2.0*51.41 + 11.36 – 33.2)/20.734]/0.02

= 68.12°F

T is calculated by adding the ART:

T = 68.1 + 146

= 214.1°F for P = 1070 psig at 38 EFPY

This temperature represents the limiting point on Curve B and is cited in Table 2 as 214.3°F.

Feedwater Nozzle Calculations

An evaluation was performed for the FW nozzle as described in Section 4.3.2.1.3 of the LTR. The first part of the evaluation is as described earlier, where it is assured that the limiting component that is represented by the upper vessel nozzle curve is bounded by the [[ ]]. A second evaluation was performed using the BFNP Unit 1-specific FW nozzle dimensions; this evaluation is shown below to demonstrate that the [[ ]] curve is applicable to BFNP Unit 1:

Vessel radius to base metal, R_v	[[
Vessel thickness, t_v	
Vessel pressure, P_v	
Pressure stress = PR/t = [[ ]]	
Dead Weight + Thermal Restricted Free End stress	
Total Stress = [[ ]]	]]

The factor F (a/r_n) from Figure A5-1 of "PVRC Recommendations on Toughness Requirements for Ferritic Materials," WRC Bulletin 175, August 1972 (WRC-175) is determined where:

$a = \frac{1}{4} (t_n^2 + t_v^2)^{1/2}$	[[
t_n = thickness of nozzle	
t_v = thickness of vessel	
r_n = apparent radius of nozzle = $r_i + 0.29*r_c$	
r_i = actual inner radius of nozzle	
r_c = nozzle radius (nozzle corner radius)	]]

Therefore, a/r_n = [[ ]]. The value F (a/r_n), taken from Figure A5-1 of WRC-175 for an [[ ]]. Including the safety factor of 1.5, the stress intensity factor, K_I, is $1.5\ \sigma\ (\pi a)^{1/2} * F(a/r_n)$:

BFNP Unit 1 Plant-Specific Nominal K_I = 1.5 * [[ ]]

A detailed upper vessel example calculation for core not critical conditions is provided in Section 4.3.2.1.4 of the LTR. Section 4.3.2.1.3 of the LTR presents the [[ ]] for the FW nozzle evaluation upon which the baseline non-shifted upper vessel P-T curve is based. It can be seen that the nominal K_I from this BFNP Unit 1 evaluation is [[ ]]. Therefore, it has been shown that the nominal K_I for the BFNP Unit 1-specific FW nozzle is less than the [[ ]] K_I, demonstrating applicability of the FW nozzle curve for BFNP Unit 1.

ENCLOSURE 4

Enclosed are the affidavits supporting the request to withhold proprietary information (included in Enclosure 2) from the public.

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Peter M. Yandow, state as follows:

(1) I am the Vice President, Nuclear Plant Projects/Services Licensing, Regulatory Affairs, of GE-Hitachi Nuclear Energy Americas LLC ("GEH"), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in GEH proprietary report, NEDC-33445P, "Tennessee Valley Authority Browns Ferry Nuclear Plant Unit 1 Pressure and Temperature Limits Report (PTLR) Up to 25 and 38 Effective Full-Power Years," dated December 2013. The GEH proprietary information in NEDC-33445P is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the *Freedom of Information Act* ("FOIA"), 5 U.S.C. Sec. 552(b)(4), and the *Trade Secrets Act*, 18 U.S.C. Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F.2d 871 (D.C. Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F.2d 1280 (D.C. Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a. and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information that discloses trade secret or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH,

and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited to a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary or confidentiality agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains the detailed GEH methodology for pressure-temperature curve analysis for the GEH Boiling Water Reactor (BWR). These methods, techniques, and data along with their application to the design, modification, and analyses associated with the pressure-temperature curves were achieved at a significant cost to GEH.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience databases that constitute a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 6th day of December 2013.

Peter M. Yandow
Vice President, Nuclear Plant Projects/Services
Licensing, Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
3901 Castle Hayne Rd.
Wilmington, NC 28401
Peter.Yandow@ge.com

ELECTRIC POWER RESEARCH INSTITUTE

2013-215 BWR Vessel & Internals Project (BWRVIP)

December 9, 2013

Brian Eber
Technical Services
Lead Project Manager
GE Hitachi Nuclear Energy
3901 Castle Hayne Road
ATC2 Second Floor, Cube 4337
Wilmington, NC 28401 USA

Subject: Transmittal of EPRI Proprietary Affidavit to the NRC

The purpose of this letter is to transmit a proprietary affidavit for transmittal of the following document to the NRC:

"GE Hitachi Nuclear Energy, NEDC-33445P, Revision 0, December 2013, Tennessee Valley Authority Browns Ferry Nuclear Plant Unit 1 Pressure and Temperature Limits Report (PTLR) up to 25 and 38 Effective Full Power Years"

If you have any questions on this subject, please contact Andrew McGehee by telephone at 704-502-6440 or by email at amcgehee@epri.com.

Sincerely,

A. O. McGehee

Andrew McGehee
EPRI, BWRVIP Program Manager

c: Vic Schiavone, TVA

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Christine King
Director, Director, Nuclear Fuels & Chemistry
Nuclear Power Sector

December 6, 2014

Document Control Desk
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Request for Withholding of the Following Proprietary Information Included in:

GE Hitachi Nuclear Energy, NEDC-33445P, Revision 0, December 2013, Tennessee Valley Authority Browns Ferry Nuclear Plant Unit 1 Pressure and Temperature Limits Report (PTLR) up to 25 and 38 Effective Full Power Years

To Whom It May Concern:

This is a request under 10 C.F.R. §2.390(a)(4) that the U.S. Nuclear Regulatory Commission ("NRC") withhold from public disclosure the information identified in the enclosed Affidavit consisting of the proprietary information owned by Electric Power Research Institute, Inc. ("EPRI") identified in the attached report. Proprietary and non-proprietary versions of the Report and the Affidavit in support of this request are enclosed.

EPRI desires to disclose the Proprietary Information in confidence to assist the NRC review of the enclosed submittal by Tennessee Valley Authority for Browns Ferry Nuclear Plant Unit 1 PTLR. The Proprietary Information is not to be divulged to anyone outside of the NRC nor shall any copies be made of the Proprietary Information provided herein. EPRI welcomes any discussions and/or questions relating to the information enclosed.

If you have any questions about the legal aspects of this request for withholding, please do not hesitate to contact me at (650) 855-2164. Questions on the content of the Report should be directed to Andy McGehee of EPRI at (704) 502-6440.

Sincerely,

Christine King

Attachment(s)

AFFIDAVIT

RE: Request for Withholding of the Following Proprietary Information Included in:

GE Hitachi Nuclear Energy, NEDC-33445P, Revision 0, December 2013, Tennessee Valley Authority Browns Ferry Nuclear Plant Unit 1 Pressure and Temperature Limits Report (PTLR) up to 25 and 38 Effective Full Power Years

I, Christine King, being duly sworn, depose and state as follows:

I am the Director, Nuclear Fuels & Chemistry at Electric Power Research Institute, Inc. whose principal office is located at 3420 Hillview Avenue, Palo Alto, California ("EPRI") and I have been specifically delegated responsibility for the above-listed report that contains EPRI Proprietary Information that is sought under this Affidavit to be withheld ("Proprietary Information"). I am authorized to apply to the U.S. Nuclear Regulatory Commission ("NRC") for the withholding of the Proprietary Information on behalf of EPRI.

EPRI Information is identified by a solid underline inside double square brackets. [[This sentence is an example.]]{E} Tables containing EPRI proprietary information are identified with double square brackets before and after the object. In each case the superscript notation {E} refers to this affidavit as the bases for the proprietary determination.

EPRI requests that the Proprietary Information be withheld from the public on the following bases:

Withholding Based Upon Privileged And Confidential Trade Secrets Or Commercial Or Financial Information (see e.g. 10 C.F.R. §2.390(a)(4)):

a. The Proprietary Information is owned by EPRI and has been held in confidence by EPRI. All entities accepting copies of the Proprietary Information do so subject to written agreements imposing an obligation upon the recipient to maintain the confidentiality of the Proprietary Information. The Proprietary Information is disclosed only to parties who agree, in writing, to preserve the confidentiality thereof.

b. EPRI considers the Proprietary Information contained therein to consitiute trade secrets of EPRI. As such, EPRI holds the Information in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Information.

c. The information sought to be withheld is considered to be proprietary for the following reasons. EPRI made a substantial economic investment to develop the Proprietary Information and, by prohibiting public disclosure, EPRI derives an economic benefit in the form of licensing royalties and other additional fees from the confidential nature of the Proprietary Information. If the Proprietary Information were publicly available to consultants and/or other businesses providing services in the electric and/or nuclear power industry, they would be able to use the Proprietary Information for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Proprietary Information.

d. EPRI's classification of the Proprietary Information as trade secrets is justified by the Uniform Trade Secrets Act which California adopted in 1984 and a version of which has been adopted by over

40 states. The California Uniform Trade Secrets Act, California Civil Code §§3426 – 3426.11, defines a "trade secret" as follows:

> "Trade Secret" means information, including a formula, pattern, compilation, program device, method, technique, or process, that:
>
> (1) Derives independent economic value, actual or potential, from not being generally known to the pubic or to other persons who can obtain economic value from its disclosure or use; and
>
> (2) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy."

e. The Proprietary Information contained therein are not generally known or available to the public. EPRI developed the Information only after making a determination that the Proprietary Information was not available from public sources. EPRI made a substantial investment of both money and employee hours in the development of the Proprietary Information. EPRI was required to devote these resources and effort to derive the Proprietary Information. As a result of such effort and cost, both in terms of dollars spent and dedicated employee time, the Proprietary Information is highly valuable to EPRI.

f. A public disclosure of the Proprietary Information would be highly likely to cause substantial harm to EPRI's competitive position and the ability of EPRI to license the Proprietary Information both domestically and internationally. The Proprietary Information can only be acquired and/or duplicated by others using an equivalent investment of time and effort.

I have read the foregoing and the matters stated herein are true and correct to the best of my knowledge, information and belief. I make this affidavit under penalty of perjury under the laws of the United States of America and under the laws of the State of California.

Executed at 3420 Hillview Avenue, Palo Alto, California being the premises and place of business of Electric Power Research Institute, Inc.

Date: 12/6/2013

[signature] Christine King

Christine King

(State of California)
(County of Santa Clara)

Subscribed and sworn to (or affirmed) before me on this 6th day of December, 2013 by Christine King, proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

Signature [signature] (Seal)
My Commission Expires 20 day of March, 2015

BERTE A. DAHL
COMM. # 1926383
NOTARY PUBLIC-CALIFORNIA
SANTA CLARA COUNTY
MY COMM. EXP. MAR. 20, 2015