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ATTACHMENT 5 to JAFP-08-0067

Entergy Nuclear Operations, Inc.
James A. FitzPatrick Nuclear Power Plant

Structural Integrity Associates
Calculation No. 0800846.302, Revision 0, "Comparison of Instrument Nozzle (N16) and Beltline P-T Curves," 7/22/2008

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ATTACHMENT 5 to JAFP-08-0067 CONTENTS

1) SIA Calculation 0800846.302 **18 Pages**

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1.0 INTRODUCTION

The purpose of this calculation is to assess the 2" instrument nozzles (N16A and N16B) located in the reactor pressure vessel (RPV) of the James A. FitzPatrick Nuclear Power Plant (JAFNPP) from a brittle fracture perspective. This evaluation is being performed to address questions raised by the NRC about the impact of these nozzles on the recently revised JAFNPP pressure-temperature (P-T) curves [2], due to their proximity to the RPV beltline region. Specifically, since the fluence exposure of these nozzles is greater than 1×10^{17} n/cm^2 during the operating life of the reactor, the NRC has questioned whether the nozzles are bounded by the beltline P-T curves, which are based on the limiting beltline plate material with the highest fluence.

2.0 METHODOLOGY

The recently revised adjusted reference temperature (ART) calculations, reference temperature shift (ΔRT_{NDT}) calculations, and P-T curve calculations for JAFNPP are documented in References [1] and [2]. Those calculations provide most of the necessary input for the work performed herein for the N16 nozzles.

In this calculation, ART values are calculated for 32 effective full power years (EFPY) for the lower intermediate plates at the N16 nozzle locations, using fluence values provided for these specific locations, and using NRC Regulatory Guide 1.99, Revision 2 methodology [3]. P-T Curves A (Pressure Test) and B (Normal Operation, Core Not Critical) are calculated for the N16 nozzles for 32 EFPY of operation, using the fracture mechanics solution shown in Figure 1 [11]. A nozzle corner flaw equal to ¼-thickness (¼t) of the RPV wall thickness is assumed for all calculations. The nozzle curves are compared to the 32 EFPY beltline curves developed in Reference [2] to demonstrate that the previously developed beltline curves are bounding. The N16 curves are developed consistent with ASME Code, Section XI, Appendix G (2001 Edition including the 2003 Addenda) [4] and 10CFR50, Appendix G [5] methodology, as was done for the previous JAFNPP beltline P-T curves. In addition, methodology consistent with the Pressure-Temperature Limits Report (PTLR) methodology [10] is used.

2.1 ART and ΔRT_{NDT} Values

The methodology for calculating the ART and ΔRT_{NDT} values was previously defined in Reference [1]. ART values for the beltline region of the JAFNPP reactor vessel were computed in that document for 32, 40, 48 and 54 EFPY.

Based on Reference [6], the JAFNPP N16A and N16B instrument nozzles are located at the 40° (A) and 220° (B) RPV azimuths, at an elevation of 358 inches above "Vessel 0" (inside surface of RPV bottom head). From Figure 3-2 of Reference [7], this places the instrument nozzles in the lower-intermediate shell plates of the reactor vessel. From Figure 4-4 and Table 4-1 of Reference [9], the nozzles are located in the reactor plates with Heat No.'s C3278-2 (A) and C3368-1 (B).

The nozzles consist of a stainless steel pipe welded into the RPV wall with austenitic material [8]. Because of the presence of austenitic material, which is inherently ductile and does not possess a brittle fracture concern, the only issue with these nozzles is the stress concentration effect of the nozzle on the RPV base plate itself. Therefore, the ART values for the N16 instrument nozzles are computed using the same parameters as the lower-intermediate vessel shell plates, except that the fluence values used are determined where the nozzle diameter interfaces with the RPV base metal. While not quite a best-estimate value from an actual nozzle model, TransWare Enterprises Inc. has indicated that the fluence value at this interface is within the uncertainties of the fluence modeling process [12].

2.2 P-T Curves

P-T curves are computed for the N16 instrument nozzles for the following plant conditions: Pressure Test (Curve A) and Normal Operation/Core Not Critical (Curve B). The curves are then compared to the existing beltline P-T curves, which were developed in Reference [2], to verify that the N16 nozzles are bounded by the beltline limits. Calculations for Normal Operation – Core Critical (Curve C) conditions are not required, since the Curve C limits are an extension of the Curve B limits.

The methodology for calculating P-T curves is described in Reference [10], and was applied in the Reference [2] calculation. Thus, all equations and values in this section are obtained from Reference [10], unless otherwise noted. One exception is the instrument nozzle fracture mechanics solution; although a nozzle solution is provided in Reference [10], it applies to a different nozzle geometry than that of the instrument nozzles. Therefore, a solution appropriate to the N16 nozzle geometry is applied in this evaluation (Figure 1). The N16 instrument nozzle P-T curves are calculated by means of an iterative procedure that is identical to the procedure specified in Reference [10] for nozzles, in which the following steps are completed:

Step 1: A fluid temperature, T, is assumed. The P-T curves are calculated under the premise of a flaw that has extended ¼ of the way through the vessel wall. According to Reference [10], the temperature at the assumed flaw tip, $T_{1/4}$, is conservatively assumed to be equal to the RPV fluid temperature.

Step 2: The static fracture toughness, K_{Ic}, is computed using the following equation:

$$K_{Ic} = 20.734 \cdot e^{0.02(T-ART)} + 33.2 \qquad (1)$$

where:
- K_{Ic} = the lower-bound static fracture toughness ($ksi\sqrt{inch}$)
- T = the metal temperature at the tip of the postulated ¼ through-wall flaw (°F), as described above
- ART = the ART value for the RPV plate at the N16 nozzle location (°F)

Step 3: The allowable stress intensity factor due to pressure, K_{Ip}, is calculated as:

$$K_{Ip} = \frac{K_{Ic} - K_{It}}{SF} \tag{2}$$

Where:
- K_{Ip} = the allowable stress intensity factor due to membrane (pressure) stress ($ksi\sqrt{inch}$)
- K_{Ic} = the lower-bound static fracture toughness factor calculated in Equation 1 ($ksi\sqrt{inch}$)
- K_{It} = the thermal stress intensity factor ($ksi\sqrt{inch}$)
- SF = the safety factor, based on the reactor condition

For hydrostatic and leak test conditions (i.e., P-T Curve A), SF = 1.5. For normal operation (i.e., P-T curve B), SF = 2.0. For Curve A, the thermal stress intensity factor is neglected (K_{It} = 0), since the hydrostatic leak test is performed at or near isothermal conditions (typically, the rate of temperature change is 25°F/hr or less).

For Curve B, K_{It} is obtained from the stress distribution output of a finite element model (FEM), in a similar fashion to the feedwater nozzle / upper vessel region discussed in Reference [10]. A thermal transient finite element analysis (FEA) is performed, and a polynomial curve-fit is developed for the through-wall stress distribution at each time point of the bounding thermal transient. The subsequent equation to evaluate K_{It} is [11]:

$$K_{It_Poly} = \sqrt{\pi a}\left[0.723C_{0t} + \frac{2a}{\pi}\cdot 0.551C_{1t} + \frac{a^2}{2}\cdot 0.462C_{2t} + \frac{4a^3}{3\pi}\cdot 0.408C_{3t}\right] \tag{3}$$

where:
- a = ¼ through-wall postulated flaw depth, a = ¼ t of cross section evaluated (in.)
- C_{0t},C_{1t}, C_{2t},C_{3t} = thermal stress polynomial coefficients, obtained from a curve-fit of the extracted stresses from an FEM thermal transient analysis.

The thermal stress polynomial coefficients are based on the assumed polynomial form of $\sigma(x) = C_0 + C_1 \cdot x + C_2 \cdot x^2 + C_3 \cdot x^3$, where "x" represents the distance in inches from the inside surface to any point on the crack front along the nozzle cross section (see Figure 1).

The transient FEA is performed to determine the maximum thermal stress that occurs during the limiting normal/upset thermal transient applicable to the N16 nozzle. Thus, the value of K_{It} calculated in Equation 3 represents the maximum thermal stress for the limiting thermal transient and is conservatively used for all points in the P-T curve calculations.

Step 4: For the instrument nozzle, the allowable pressure is determined from a ratio of the allowable and applied stress intensity factors. The applied factor can be determined from an FEM that outputs the stresses due to the internal pressure on the nozzle / RPV. The methodology for this approach is as follows:

$$P_{allow} = \frac{K_{Ip} \cdot P_{ref}}{K_{Ip-app}} \tag{4}$$

where:
- P_{allow} = the allowable RPV internal pressure (psig)
- P_{ref} = RPV internal pressure at which the finite element analysis was performed (psig)
- K_{Ip} = the allowable stress intensity factor due to membrane (pressure) stress, as defined in Equation 2 ($ksi\sqrt{inch}$)
- $K_{Ip\text{-}app}$ = the applied pressure stress intensity factor ($ksi\sqrt{inch}$)

The applied pressure stress intensity factor is determined using a polynomial curve-fit approximation for the through-wall pressure stress distribution from an FEA, similar to the methodology of Equation 3:

$$K_{Ip-app} = \sqrt{\pi a}\left[0.723C_{0p} + \frac{2a}{\pi}\cdot 0.551C_{1p} + \frac{a^2}{2}\cdot 0.462C_{2p} + \frac{4a^3}{3\pi}\cdot 0.408C_{3p}\right] \tag{5}$$

Where:
- a = ¼ through-wall postulated flaw depth, a = ¼ t of cross section evaluated (in.)
- $C_{0p}, C_{1p}, C_{2p}, C_{3p}$ = pressure stress polynomial coefficients, obtained from a curve-fit of the extracted stresses from an FEM unit pressure analysis

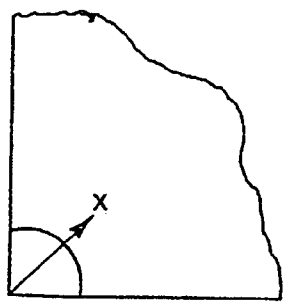
Step 5: The final P-T limits are calculated using the following equations:

$$T_{P-T} = T + U_T \tag{6}$$

$$P_{P-T} = P_{allow} - P_H - U_P \tag{7}$$

where:
- T = the metal temperature at the tip of the postulated ¼ through-wall flaw (°F)
- $T_{P\text{-}T}$ = the allowable coolant (metal surface) temperature (°F)
- U_T = the coolant temperature instrument uncertainty (°F)
- $P_{P\text{-}T}$ = the allowable reactor pressure (psig)
- P_H = the pressure head to account for the water in the RPV (psig), calculated as, $P_H = \rho \cdot \Delta h$
  = 29.8 psig (same as Reference [2])
- ρ = water weight density at ambient temperature (lbm/ft^3)
- Δh = elevation of normal water level in RPV (in.)
- U_P = the pressure instrument uncertainty (psig)

Step 6: The fluid temperature (T) is incremented, and the calculations resume from Step 1. Calculations proceed in this iterative manner until the allowable reactor pressure ($P_{P\text{-}T}$) exceeds the maximum possible operating pressure. The maximum pressure is usually set to 1,600 psig, since this value bounds the typical pre-service ASME Code hydrostatic test pressure of 1,563 psig.



FUN 10 – QUARTER-CIRCULAR CRACK IN QUARTER-SPACE

$$K_I = \sqrt{\pi a}\,[0.723\,A_0 + 0.551\,(\frac{2a}{\pi})\,A_1 + 0.462\,(\frac{a^2}{2})\,A_2 + 0.408(\frac{4a^3}{3\pi})\,A_3\,]$$

Figure 1: Instrument Nozzle Fracture Mechanics Model [11]

3.0 DESIGN INPUTS / ASSUMPTIONS

3.1 ART and ΔRT_{NDT} Values

As discussed in Section 2.1, the JAFNPP N16 instrument nozzles are located in the lower-intermediate shell plates of the reactor vessel. ART values for these plates were previously generated in Reference [1] for the point of maximum fluence. ART values for the instrument nozzles are therefore computed using parameters identical to the vessel plates, except that the fluence is changed to reflect the level at the N16 nozzle locations. The fluence values at the instrument nozzle locations are provided in Reference [12].

3.2 P-T Curves

The latest JAFNPP P-T curves are documented in Reference [2]. Curves were computed for the beltline, bottom head, and upper vessel / feedwater nozzle regions for 32, 40, 48 and 54 EFPY. Unless explicitly stated below, inputs for the instrument nozzle P-T curves were obtained from the previous P-T curves. The beltline comparison curves for 32 EFPY are obtained directly from Reference [2].

ART values for the instrument nozzles are calculated at 32 EFPY in Section 4.1. The polynomial coefficients needed for Equations 3 and 5 are calculated in Section 3.3, based on the stress distributions obtained from the FEA output files of Reference [13]. The pressure and temperature instrument uncertainties are taken as 0 psig and 0°F, respectively, which mirrors the assumptions of Reference [2].

3.3 Polynomial Stress Coefficients

The pressure and thermal stress analyses performed in Reference [13] generated a series of nozzle corner stress distributions for use in the fracture mechanics model in Figure 1. Since the maximum pressure stress occurred at a different location than the maximum thermal stress, the stress distributions were reported for two paths, as shown in Figures 9 and 10 of Reference [13].

The pressure stress distributions for Paths 1 and 2 are fit with a third-order polynomial equation. Stress intensity factors were calculated for the pressure stress coefficients using Equation 5. A maximum pressure stress intensity factor of 60.266 $ksi\sqrt{inch}$ was calculated from the Path 2 coefficients; this value will be used in the ensuing P-T curve calculations. The curve fit for the limiting Path 2 stress history is shown in Figure 2, and the polynomial coefficients are provided in Table 1. Note that although the polynomial fit does not adequately represent the entire stress distribution, the correlation is satisfactory at the ¼t location of interest (approximately 1.8 inches into the RPV wall).

Thermal stress analyses were performed for two separate transients in Reference [13]: (1) the Loss of Feedwater Pumps (LOFP) event, and (2) the Safety Relief Valve (SRV) Blowdown event. Each analysis resulted in a number of stress distributions, one for each time step that was evaluated. The minimum temperature during an LOFP transient is 300°F, as shown in Table 6 of Reference [13], whereas an SRV Blowdown event transitions from rated temperature to ambient temperature. Since the temperature range of interest for the P-T curves is well below 300°F, it is assumed that only the SRV Blowdown transient is applicable for thermal stress intensity factor calculations. This assumption is justified in the P-T curve calculations in Section 4.2.

The SRV Blowdown stress distributions for Paths 1 and 2 are each fit with a third-order polynomial equation, and thermal stress intensity factors were calculated for each set of polynomial coefficients using Equation 3. Using this approach, a maximum stress intensity factor of 28.345 $ksi\sqrt{inch}$ was calculated at a time of 670 seconds for the SRV Blowdown event. The curve fit for this limiting time step is plotted in Figure 3. The thermal stress polynomial fit does not adequately represent the overall stress distribution; consequently, the c0 coefficient was adjusted to ensure an accurate representation of the stress at the ¼t location of interest (approximately 1.8 inches into the RPV wall). The adjusted polynomial coefficients, which are provided in Table 1, result in a thermal stress intensity factor of 33.541 $ksi\sqrt{inch}$; this value will be used in the ensuing P-T curve calculations.

Table 1: Polynomial Coefficients

Instrument Nozzle Pressure Stress Coefficients				$K_{Ip\text{-}applied}$
c0	c1	c2	c3	(psi*inch$^{1/2}$)
42,980.0	-18,287.7	12,187.9	-3,207.1	60,266
Instrument Nozzle Thermal Stress Coefficients				K_{It}
c0	c1	c2	c3	(psi*inch$^{1/2}$)
52,575.0	-29,139.5	-26,085.1	13,818.1	33,541

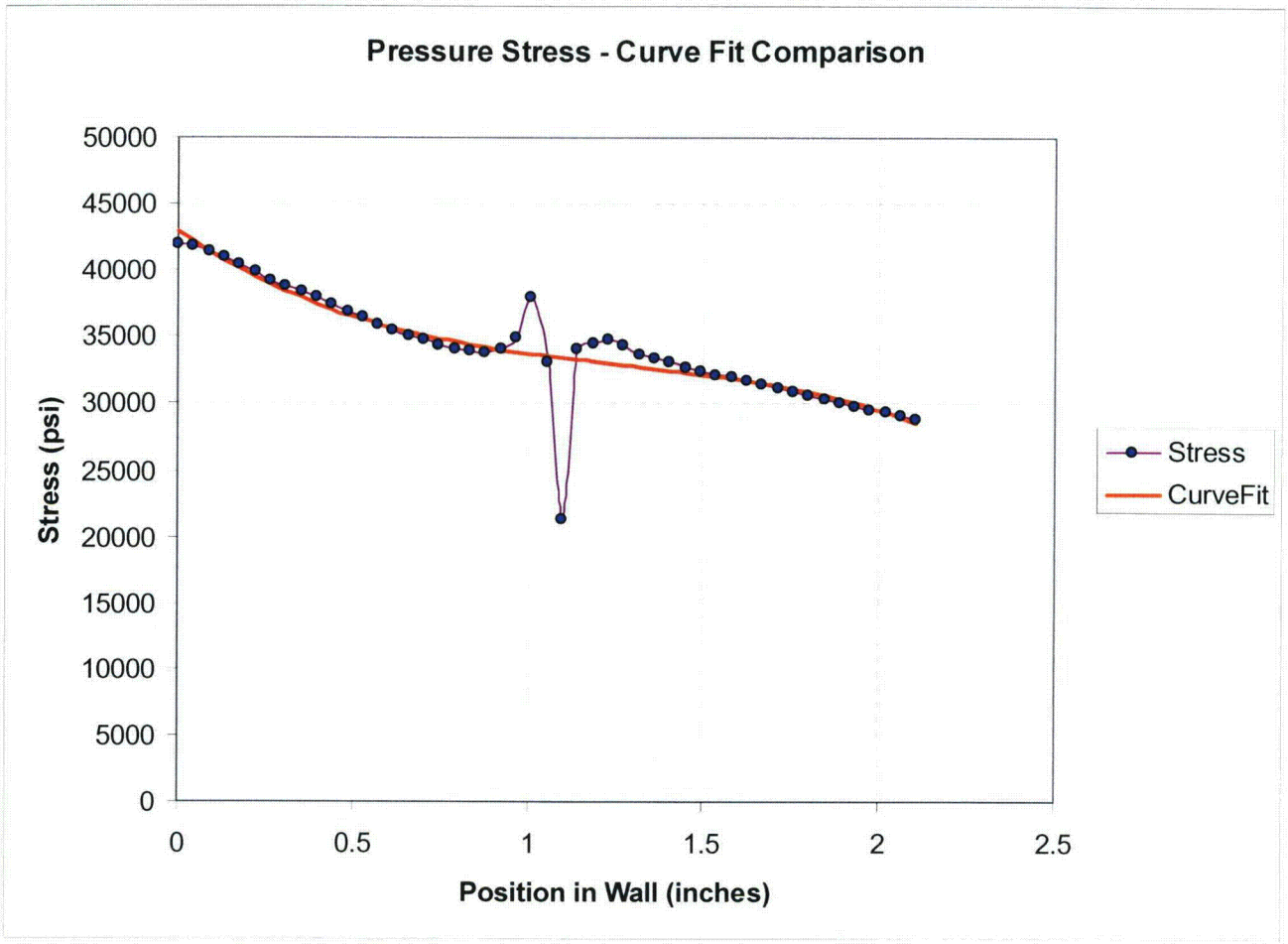


Figure 2: Pressure Stress Curve Fit Comparison

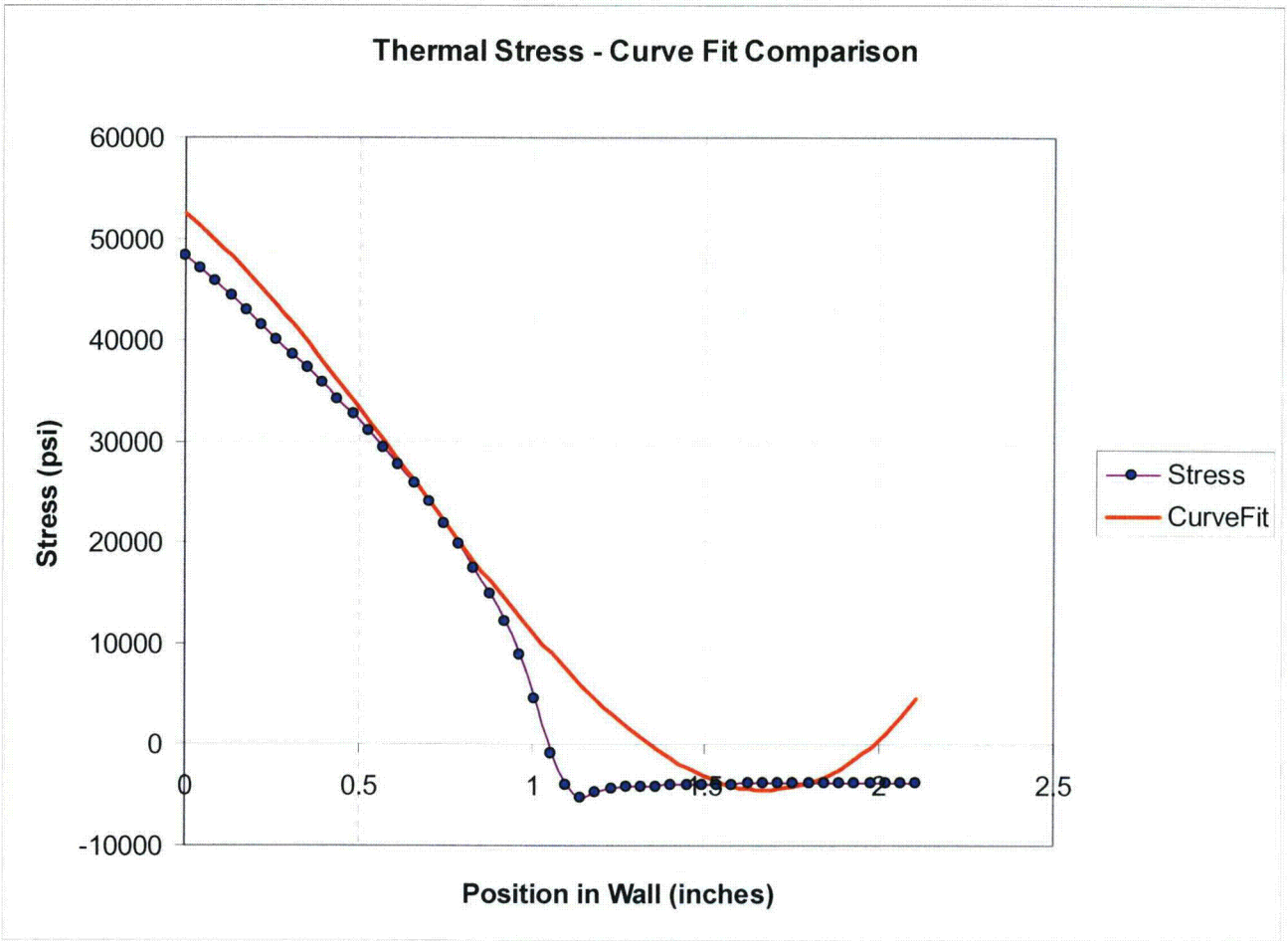


Figure 3: Thermal Stress Curve Fit Comparison

4.0 CALCULATIONS

4.1 ART and ΔRT_{NDT} Values

ART values are determined at 32 EFPY for the two JAFNPP N16 instrument nozzles, using the methodology discussed in Section 2.1 and a fluence of 4.6×10^{17} n/cm^2 at 32 EFPY per Reference [12]. The resulting calculations are provided in Table 2. The N16A instrument nozzle, located in the lower-intermediate plate #2 (C3278-2), has the limiting ART value of 31.8°F at 32 EFPY.

Table 2: Instrument Nozzle ART Calculations – 32 EFPY

Description	Code No.	Heat No.	Plate Location	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
								ΔRT_{NDT}	Margin Terms		ART_{NDT}
					Cu (wt %)	Ni (wt %)		(°F)	σ_Δ (°F)	σ_I (°F)	(°F)
Nozzle N16B	-	-	L.I. Shell #1, C3368-1	-10.0	0.12	0.50	81.00	18.9	9.5	0.0	27.8
Nozzle N16A	**-**	**-**	**L.I. Shell #2, C3278-2**	**-10.0**	**0.11**	**0.61**	**89.56**	**20.9**	**10.5**	**0.0**	**31.8**

Fluence Data						
Location	Wall Thickness (in)		Fluence at ID	Attenuation, 1/4t	Fluence at 1/4t	Fluence Factor, FF
	Full	1/4t	(n/cm^2)	$e^{-0.24x}$	(n/cm^2)	$f^{(0.28 - 0.10 \log f)}$
Nozzle N16B	5.375	1.344	4.60E+17	0.724	3.332E+17	0.233
Nozzle N16A	5.375	1.344	4.60E+17	0.724	3.332E+17	0.233

4.2 P-T Curves

For the Curve A calculations, the minimum bolt-up temperature of 60°F [2] is applied to the instrument nozzle as the initial temperature in the iterative calculation process. The P-T curve points are calculated using the methodology in Section 2.2, and the data at 32 EFPY is provided in tabular form in Table 3. Figure 4 is a graphical comparison of the Curve A plots for the instrument nozzle and the RPV beltline.

For the Curve B calculations, the initial temperature is again set equal to the minimum bolt-up temperature of 60°F. Since the temperature range of interest does not exceed 300°F, the LOFP transient is not applicable, and the maximum SRV Blowdown thermal stress intensity listed in Table 1 is applicable over the entire temperature range. The 32 EFPY data is presented in tabular form in Table 4, and compared graphically to the beltline region Curve B in Figure 5.

The purpose of this document is only to demonstrate that the beltline locations are limiting compared to the instrument nozzles; this does not require development of a full set of P-T curves. Based on the discussion in the first paragraph of Section 2.2, demonstrating that the beltline region is limiting for Curve B inherently demonstrates the same for Curve C.

Table 3: JAFNPP Instrument Nozzle Curve A for 32 EFPY

Plant =	**Fitzpatrick**	
Component =	**Instrument Nozzle**	
ART =	**31.80**	°F ======> **All EPFY**
Vessel Radius, R =	**110.38**	inches
Nozzle corner thickness, t =	**7.15**	inches, approximate
K_{It} =	**0.00**	ksi*inch$^{1/2}$
$K_{Ip\text{-}applied}$ =	**60.27**	ksi*inch$^{1/2}$
Crack Depth, a =	**1.79**	inches
Safety factor =	**1.50**	
Temperature Adjustment =	**0.00**	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	**825.20**	inches
Pressure Adjustment =	**29.80**	psig (hydrostatic pressure head for a full vessel at 70°F)
Pressure Adjustment =	**0.00**	psig (instrument uncertainty)
Reference Pressure =	**1,000**	psig (pressure at which FEA stress coefficients are valid)
Unit Pressure =	**1,563**	psig (hydrostatic pressure)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi*inch$^{1/2}$)	K_{Ip} (ksi*inch$^{1/2}$)	Temperature for P-T C urve (°F)	Adjusted Pressure for P-T Curve (psig)
60.0	69.64	46.43	60.0	0
60.0	69.64	46.43	60.0	741
62.0	71.13	47.42	62.0	757
64.0	72.68	48.45	64.0	774
66.0	74.29	49.53	66.0	792
68.0	75.97	50.64	68.0	811
70.0	77.71	51.81	70.0	830
72.0	79.53	53.02	72.0	850
74.0	81.42	54.28	74.0	871
76.0	83.39	55.59	76.0	893
78.0	85.44	56.96	78.0	915
80.0	87.57	58.38	80.0	939
82.0	89.79	59.86	82.0	963
84.0	92.10	61.40	84.0	989
86.0	94.50	63.00	86.0	1,016
88.0	97.00	64.67	88.0	1,043
90.0	99.61	66.40	90.0	1,072
92.0	102.32	68.21	92.0	1,102
94.0	105.14	70.09	94.0	1,133
96.0	108.07	72.05	96.0	1,166
98.0	111.13	74.08	98.0	1,199
100.0	114.31	76.20	100.0	1,235
102.0	117.62	78.41	102.0	1,271
104.0	121.06	80.71	104.0	1,309
106.0	124.65	83.10	106.0	1,349
108.0	128.38	85.59	108.0	1,390
110.0	132.26	88.18	110.0	1,433
112.0	136.31	90.87	112.0	1,478
114.0	140.52	93.68	114.0	1,525
116.0	144.90	96.60	116.0	1,573
118.0	149.45	99.64	118.0	1,623

Table 4: JAFNPP Instrument Nozzle Curve B for 32 EFPY

Plant =	Fitzpatrick	
Component =	Instrument Nozzle	
ART =	31.80	°F ======> All EPFY
Vessel Radius, R =	110.38	inches
Nozzle corner thickness, t =	7.15	inches, approximate
K_{It} =	33.54	ksi*inch$^{1/2}$
$K_{Ip\text{-}applied}$ =	60.27	ksi*inch$^{1/2}$
Crack Depth, a =	1.79	inches
Safety factor =	2.00	
Temperature Adjustment =	0.00	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	825.20	inches
Pressure Adjustment =	29.80	psig (hydrostatic pressure head for a full vessel at 70°F)
Pressure Adjustment =	0.00	psig (instrument uncertainty)
Reference Pressure =	1,000	psig (pressure at which FEA stress coefficients are valid)
Unit Pressure =	1,563	psig (hydrostatic pressure)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi*inch$^{1/2}$)	K_{Ip} (ksi*inch$^{1/2}$)	Temperature for P-T C urve (°F)	Adjusted Pressure for P-T Curve (psig)
60.0	69.64	24.07	60.0	0
60.0	69.64	24.07	60.0	370
62.0	71.13	25.06	62.0	386
64.0	72.68	26.09	64.0	403
66.0	74.29	27.17	66.0	421
68.0	75.97	28.28	68.0	440
70.0	77.71	29.45	70.0	459
72.0	79.53	30.66	72.0	479
74.0	81.42	31.92	74.0	500
76.0	83.39	33.23	76.0	522
78.0	85.44	34.60	78.0	544
80.0	87.57	36.02	80.0	568
82.0	89.79	37.50	82.0	592
84.0	92.10	39.04	84.0	618
86.0	94.50	40.64	86.0	645
88.0	97.00	42.31	88.0	672
90.0	99.61	44.04	90.0	701
92.0	102.32	45.85	92.0	731
94.0	105.14	47.73	94.0	762
96.0	108.07	49.69	96.0	795
98.0	111.13	51.72	98.0	828
100.0	114.31	53.84	100.0	864
102.0	117.62	56.05	102.0	900
104.0	121.06	58.35	104.0	938
106.0	124.65	60.74	106.0	978
108.0	128.38	63.23	108.0	1,019
110.0	132.26	65.82	110.0	1,062
112.0	136.31	68.51	112.0	1,107
114.0	140.52	71.32	114.0	1,154
116.0	144.90	74.24	116.0	1,202
118.0	149.45	77.28	118.0	1,252
120.0	154.20	80.44	120.0	1,305
122.0	159.14	83.73	122.0	1,360
124.0	164.28	87.16	124.0	1,416
126.0	169.62	90.72	126.0	1,476
128.0	175.19	94.43	128.0	1,537
130.0	180.99	98.30	130.0	1,601

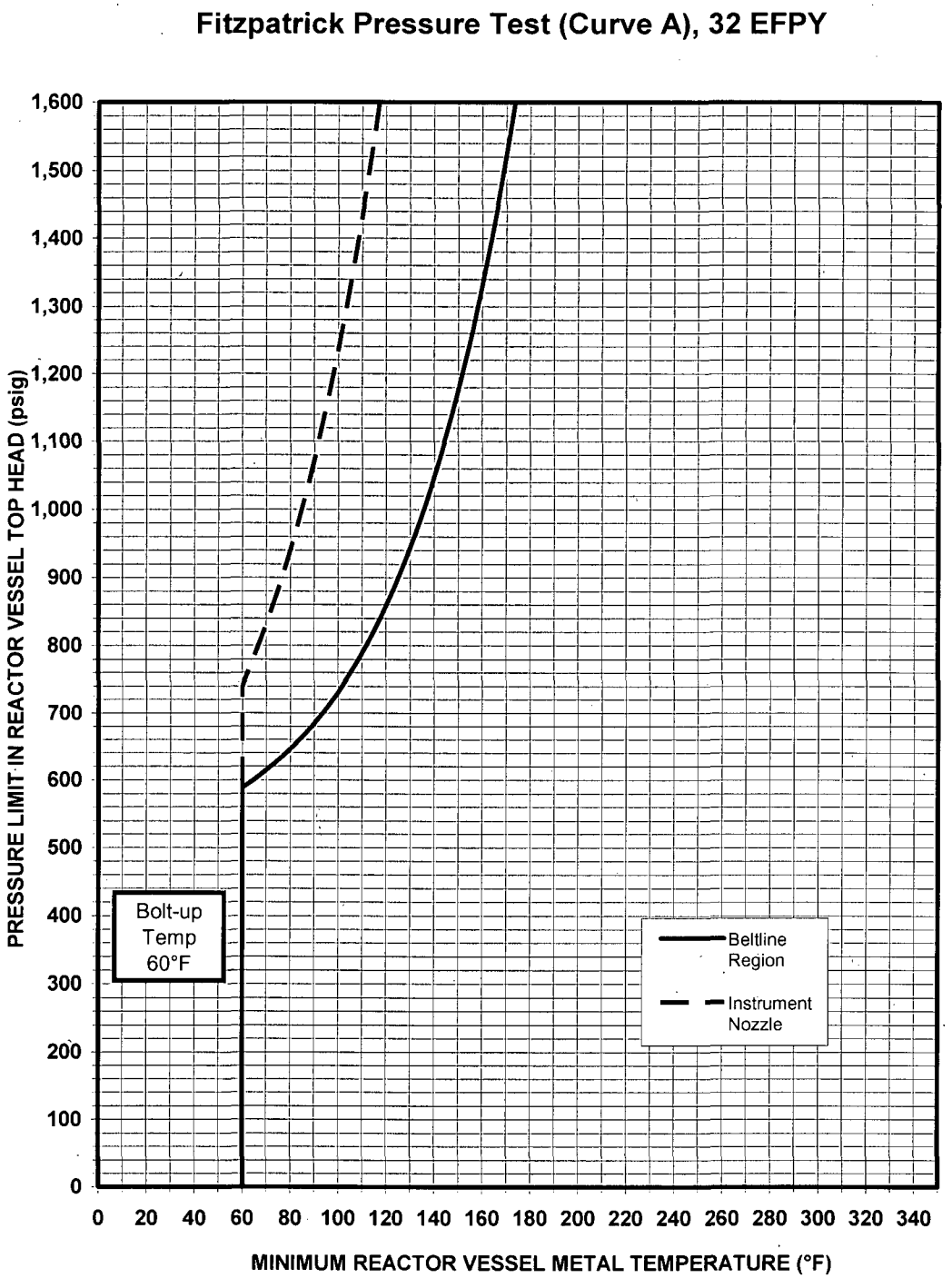


Figure 4: JAFNPP P-T Curve A Comparison for 32 EFPY

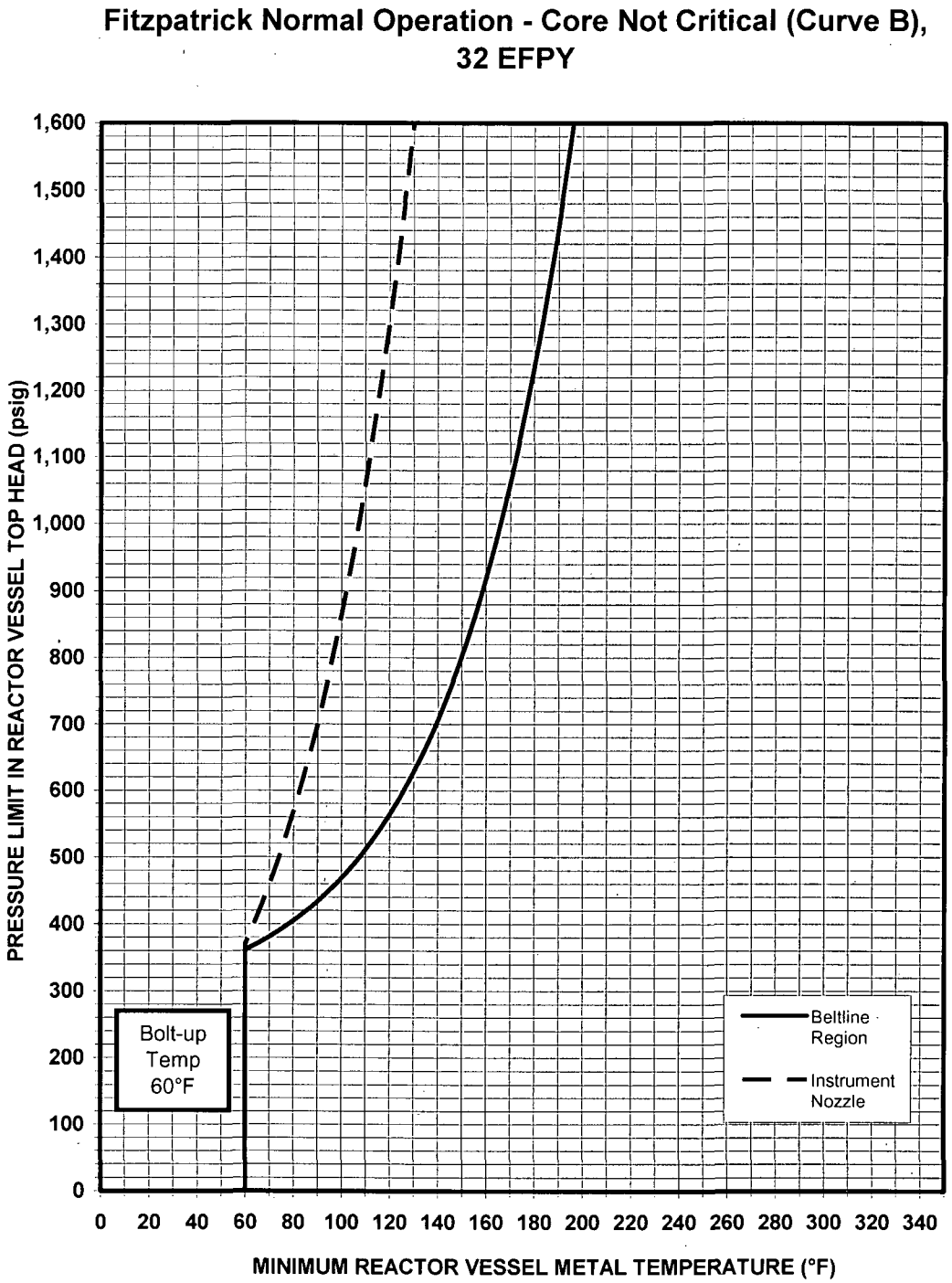


Figure 5: JAFNPP P-T Curve B Comparison for 32 EFPY

5.0 CONCLUSIONS

In this calculation, the JAFNPP RPV 2" instrument nozzles (N16A and N16B) have been evaluated from a brittle fracture perspective. This evaluation was performed to address questions raised by the NRC about the impact of these nozzles on the recently revised JAFNPP P-T curves, due to their proximity to the RPV beltline region. Specifically, since the fluence exposure of these nozzles is greater than 1×10^{17} n/cm^2 during the operating life of the reactor, the NRC has questioned whether the nozzles are bounded by the beltline P-T curves, which are based on the limiting beltline plate material with the highest fluence.

Figure 4 and Figure 5 demonstrate that the N16 nozzles are bounded by the beltline P-T limits previously established for JAFNPP in Reference [2]. Therefore, the Reference [2] P-T curves remain valid and bound the N16 nozzles through 32 EFPY of operation.

6.0 REFERENCES

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