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# ATTACHMENT 4 to JAFP-08-0067

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

## Structural Integrity Associates
## Calculation No. FITZ-10Q-302, Revision 0,
## "Revised Pressure-Temperature Curves," 2/26/2008

Attachments 2, 6, and 8 contain proprietary information as described in 10 CFR 2.390.
When separated from these attachments this letter and its contents are non-proprietary.

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**ATTACHMENT 4 to JAFP-08-0067 CONTENTS**


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| **1)** | **SIA Calculation FITZ-10Q-302** | **58 Pages** |
| | **Calculation FITZ-10Q-302 51 Pages** | |
| | **Calculation Attachment A 3 Pages** | |
| | **Calculation Attachment B 4 Pages** | |


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***Note:*** ***This calculation supersedes all previous Pressure-Temperature curve calculations for the James A. Fitzpatrick Nuclear Power Plant.***

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## 1.0 INTRODUCTION

This calculation updates the James A. Fitzpatrick Nuclear Power Plant (JAFNPP) pressure-temperature (P-T) curves for the beltline, bottom head, limiting flange and non-beltline (feedwater nozzle / upper vessel) locations. The P-T curves are created for 32, 40, 48 and 54 effective full power years (EFPY) of operation, and are developed using the methodology of the 2001 Edition, 2003 Addenda of ASME Code, Section XI, Appendix G [1], and 10CFR50 Appendix G [3]. This calculation has been developed in accordance with the methodology of the Boiling Water Reactor Owner's Group (BWROG) Licensing Topical Report, "Pressure-Temperature Limits Report Methodology for Boiling Water Reactors" [5].

## 2.0 METHODOLOGY

A full set of P-T curves are computed, including the following plant conditions: Pressure Test (Curve A), Normal Operation – Core Not Critical (Curve B), and Normal Operation – Core Critical (Curve C). The curves are consolidated into three evaluation regions of the reactor pressure vessel (RPV): (1) the beltline, (2) the bottom head, and (3) the feedwater nozzle / upper vessel.

The primary methodology for calculating P-T curves is described in Reference [5], thus, all equations and values in this section are obtained from Reference [5], unless otherwise noted. The P-T curves are calculated by means of an iterative procedure, 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 [5], the temperature at the assumed flaw tip, $T_{1/4}$, may be treated as equal to the assumed fluid temperature.

Step 2: The static fracture toughness factor, $K_{Ic}$, 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 factor ($ksi\sqrt{inch}$)
- T = the metal temperature at the tip of the postulated ¼ through-wall flaw (°F), as described above
- ART = the Adjusted Reference Temperature (ART) for the limiting material in the RPV region under consideration (°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

Note: for hydrostatic and leak test conditions (i.e. P-T Curve A), the SF = 1.5. For normal operation, for both a non-critical and a critical reactor (i.e. P-T curves B and C), the SF = 2.0. When calculating values 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 and Curve C calculations, $K_{It}$ is computed in different ways based on the evaluation region. For the beltline and bottom head regions, $K_{It}$ is determined using the following equation:

$$K_{It} = 0.953 \times 10^{-3} \cdot CR \cdot t^{2.5} \tag{3}$$

Where:
- CR = the cooldown rate of the vessel (°F/hr)
- t = the RPV wall thickness (in.)

For the feedwater nozzle / upper vessel region, $K_{It}$ is obtained from the stress distribution output of a finite element model (FEM). A thermal transient finite element analysis (FEA) is performed, and a polynomial curve-fit is applied to the through-wall stress distribution at each time point. The subsequent method to evaluate $K_{It}$ is:

$$K_{It_Poly} = \sqrt{\pi a}\left[0.706C_{0t} + \frac{2a}{\pi}\cdot 0.537C_{1t} + \frac{a^2}{2}\cdot 0.448C_{2t} + \frac{4a^3}{3\pi}\cdot 0.393C_{3t}\right] \tag{4}$$

Where:
- a = ¼ through-wall postulated flaw depth, a = ¼ t (in.)
- t = thickness of the cross-section through the limiting nozzle inner blend radius corner (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 transient analysis.

The thermal stress polynomial coefficients are based on the assumed polynomial form of $\sigma(x) = C_0 + C_1 \cdot \left( a/a_{max} \right) + C_2 \cdot \left( a/a_{max} \right)^2 + C_3 \cdot \left( a/a_{max} \right)^3$. In this equation, "a" represents the radial distance in inches from the inside surface to any point on the crack front, and "$a_{max}$" is the maximum crack depth, in inches.

The transient FEA is performed assuming a fixed thermal shock between a high and a low temperature. In reality, the available thermal shock varies for each evaluation step, as the maximum temperature is bounded by the pressure-temperature saturation curve. Thus, the value of $K_{It}$ calculated in Equation 4 can be scaled to account for the maximum available thermal shock, as shown in the following expression:

$$K_{It} = K_{It_Poly} \cdot F_{scaling} = K_{It_Poly} \cdot \left( \frac{T_{sat} - T_{low}}{T_{high} - T_{low}} \right) \tag{5}$$

Where:
- $K_{It}$ = the scaled thermal stress intensity factor, which is subsequently used in Equation 2 ($ksi\sqrt{inch}$)
- $K_{It_Poly}$ = the thermal stress intensity factor computed from the polynomial expression defined in Equation 4 ($ksi\sqrt{inch}$)
- $F_{scaling}$ = the scaling factor to apply to the polynomial stress intensity factor
- $T_{sat}$ = the saturation temperature of the reactor (°F)
- $T_{low}$ = the lower limit of the thermal shock applied to the FEA (°F)
- $T_{high}$ = the upper limit of the thermal shock applied to the FEA (°F)

$T_{sat}$ is determined from the pressure-temperature saturation curve. A power fit of this curve is developed in Appendix B, resulting in the following equation:

$$T_{sat} = 119.3 \cdot 0.7987^{\frac{1}{P_{sat}}} \cdot P_{sat}^{0.2198} \tag{6}$$

In the above equation, $P_{sat}$ is the saturation pressure corresponding to $T_{sat}$. For the purposes of this evaluation, $P_{sat}$ is conservatively applied at the final P-T curve pressure, which is calculated below in Equation 12. This results in an iterative calculation process for each evaluation step, where a saturation pressure is assumed, a scaling factor is determined, the final pressure ($P_{P\text{-}T}$) is computed, and the assumed saturation pressure is adjusted until the results achieve a suitable level of convergence.

Step 4: The allowable internal pressure of the RPV is calculated differently for each evaluation region. For the beltline region, the allowable pressure is determined as follows:

$$P_{allow} = \frac{K_{Ip} \cdot t}{M_m \cdot R_i} \tag{7}$$

Where:
- $P_{allow}$ = the allowable RPV internal pressure (psig)
- $K_{Ip}$ = the allowable stress intensity factor due to membrane (pressure) stress, as defined in Equation 2 ($ksi\sqrt{inch}$)
- t = the RPV wall thickness (in.)
- $M_m$ = the membrane correction factor for an inside surface axial flaw:
  - $M_m = 1.85$ for $\sqrt{t} < 2$
  - $M_m = 0.926\sqrt{t}$ for $2 \le \sqrt{t} \le 3.464$
  - $M_m = 3.21$ for $\sqrt{t} > 3.464$
- $R_i$ = the inner radius of the RPV (in.)

For the bottom head region, the allowable pressure is calculated with the following equation:

$$P_{allow} = \frac{2 \cdot K_{Ip} \cdot t}{SCF \cdot M_m \cdot R_i} \tag{8}$$

Where:
- SCF = conservative stress concentration factor to account for bottom head penetration discontinuities; SCF = 3.0 per Reference [5]
- $P_{allow}$, $K_{Ip}$, t, $M_m$ and $R_i$ are defined in the footnotes of Equation 7

For the feedwater nozzle / upper vessel region, 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:

$$P_{allow} = \frac{K_{Ip} \cdot P_{ref}}{K_{Ip-app}} \tag{9}$$

Where:
- $P_{ref}$ = RPV internal pressure at which the finite element analysis was performed (psig)
- $K_{Ip\text{-}app}$ = the applied pressure stress intensity factor ($ksi\sqrt{inch}$)
- $P_{allow}$ and $K_{Ip}$ are defined in the footnotes of Equation 7

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 4:

$$K_{Ip-app} = \sqrt{\pi a}\left[0.706C_{0p} + \frac{2a}{\pi} \cdot 0.537C_{1p} + \frac{a^2}{2} \cdot 0.448C_{2p} + \frac{4a^3}{3\pi} \cdot 0.393C_{3p}\right] \tag{10}$$

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

Step 5: Steps 1 through 4 are repeated in order to generate a series of P-T points; the fluid temperature is incremented with each repetition. The iteration continues until the allowable pressure has reached a value greater than the maximum operational pressure.

Step 6: The following additional minimum temperature requirements apply to the feedwater nozzle / upper vessel region, according to Table 1 of 10CFR50, Appendix G [3]:

- If the pressure is greater than 20% of the pre-service hydro-test pressure, the temperature must be greater than the $RT_{NDT}$ of the limiting flange material plus a temperature adjustment. For Curve A calculations, the temperature adjustment is 90°F; for Curve B, the temperature adjustment is 120°F.
- If the pressure is less than or equal to 20% of the pre-service hydro-test pressure, the minimum temperature must be greater than or equal to the $RT_{NDT}$ of the limiting flange material.

Step 7: The final P-T limits are calculated using the following equations:

$$T_{P-T} = T + U_T \tag{11}$$

$$P_{P-T} = P_{allow} - P_H - U_P \tag{12}$$

Where: $T_{P-T}$ = the allowable coolant (metal) temperature (°F)
$U_T$ = the coolant temperature instrument uncertainty (°F)
$P_{P-T}$ = the allowable reactor pressure (psig)
$P_H$ = the pressure head to account for the water in the RPV (psig). Can be calculated from the following expression: $P_H = \rho \cdot \Delta h$
$\rho$ = Water weight density at ambient temperature (lbm/ft$^3$)
$\Delta h$ = elevation of normal water level in RPV (in.)
$U_P$ = the pressure instrument uncertainty (psig)

Step 8: The fluid temperature (T) is incremented, and the calculations resume from Step 1. Calculations proceed in this iterative manner until the allowable reactor pressure ($P_{P-T}$) exceeds the maximum possible pressure. The maximum pressure limit is usually set to 1600 psig, since this value bounds the typical hydrostatic test pressure of 1,563 psig (see Section 3.0).

The P-T Curves for the hydrostatic leak test (Curve A) and normal operation – core not critical (Curve B) can be computed by following Steps 1 through 7. Values for Curve C, the core-critical operating curve, are generated from the requirements of 10CFR50 Appendix G [3] and the Curve A and Curve B limits. Table 1 of Reference [3] requires that core critical P-T limits be 40°F above any Curve A or Curve B limits at all pressures. 10CFR50 Appendix G [3] also stipulates that, above the 20% pressure transition point, the Curve C temperatures must be either the reference temperature ($RT_{NDT}$) of the closure region plus 160°F, or the temperature required for the hydrostatic pressure test, whichever is greater.

For P-T Curves A and B, the initial fluid temperature assumed in Step 1 is typically taken at the bolt-up temperature of the closure flange. According to Reference [3], the minimum bolt-up temperature is equal to the limiting material $RT_{NDT}$ of the regions affected by bolt-up stresses. Consistent with Reference [5], the minimum bolt-up temperature shall not be lower than 60°F. Thus, the minimum bolt-up temperature shall be 60°F or the material $RT_{NDT}$, whichever is higher.

For P-T Curve C, when the reactor is critical, the initial fluid temperature is equal to the calculated minimum criticality temperature in this region. Table 1 of Reference [3] indicates that, for a BWR with normal operating water levels, the allowable temperature for initial criticality at the closure flange region is equal to the reference temperature ($RT_{NDT}$) at the flange region plus 60°F.

## 3.0 DESIGN INPUTS / ASSUMPTIONS

All design inputs and assumptions used to perform the JAFNPP P-T curve calculations are summarized in the input listings in Appendix A.

ART values in the JAFNPP beltline region are obtained from a previous SI calculation [6]. The calculations were performed in accordance with Nuclear Regulatory Commission (NRC) Regulatory Guide 1.99, Revision 2 (RG1.99) [4]. Based on Tables 1-4 of Reference [6], the limiting beltline material is the 2-233-A lower-shell longitudinal weld, which has ART values of 109.6°F, 118.0°F, 125.5°F, and 130.6°F for 32, 40, 48 and 54 EFPY, respectively. Since JAFNPP does not have any nozzles in the RPV beltline where the fluence exceeds $1.0 \times 10^{17}$ n/cm$^2$, it is not necessary to perform additional beltline component calculations.

Non-beltline regions are not subjected to fluence; therefore, reference temperature ($RT_{NDT}$) values are valid substitutions for corresponding ART values. $RT_{NDT}$ values for non-beltline regions are obtained from Tables 3-2 and 3-3 of Reference [7]. The values for the bottom head, upper vessel, and closure flange are 10°F, 20°F, and 30°F, respectively. These values remain constant for all EFPY levels in the evaluation.

The inner radius of the RPV, as defined in the drawing on page 7 of Reference [10], is 110.375 inches. The vessel shell thickness is taken as 5.375 inches from the same source Dimensions for the bottom head radius and thickness are also obtained from the drawing on page 7 of [10] as 110.5 inches and 6.8125 inches, respectively.

The GE design hydro-test pressure is defined in Reference [9] as 1,250 psig. Typically, the pre-service system hydrostatic test pressure is taken as 1.25 times the typical GE design pressure, resulting in a value of 1,563 psig. The instrument uncertainty for both temperature and pressure is assumed to be equal to zero.

The total height of the RPV is 825.2 inches, as shown in Section 8.2.7 of Reference [7]. The density of the water is assumed to be 62.4 lbm/ft$^3$. Thus, the static pressure adjustment due to the pressure head of the water in the RPV is conservatively calculated as 29.8 psig for all evaluation regions. The maximum cool-down rate of the vessel is 100°F/hr per Reference [9].

According to Section 2.8 of Reference [5], the minimum bolt-up temperature for the RPV shall be no lower than 60°F. Since the upper-vessel $RT_{NDT}$ values are all less than 60°F, the initial assumed fluid temperature in the iterative P-T curve calculation process is set equal to 60°F. A temperature increment of 2°F between subsequent iterations is assumed.

The 60°F initial temperature does not include the additional 60°F add-on margin for Curves A and B that was applied to the previous JAFNPP P-T curves [7]. This additional conservatism was required in pre-1971 ASME Section III Code, but is no longer required in ASME Section XI, Appendix G [1] or 10CFR50, Appendix G [3]. When the PTLR [5] was developed, SI consciously recognized the additional 60°F margin and chose to exclude it, as it is not technically required.

The polynomial coefficients used to calculate the stress intensity factors for the feedwater nozzle / upper vessel region are obtained from a detailed FEA previously performed for JAFNPP [11]. A transient thermal stress analysis was performed for the transient described in Reference [11]. A pressure stress analysis was also performed for a 1000 psig RPV pressure. A linearized stress path was created through the nozzle's blend radius corner, and the limiting thermal and pressure stress distributions were extracted from the FEM results. In Reference [8], each stress distribution in Reference [11] was fit with a third-order polynomial as a function of distance into the nozzle; the polynomial coefficients are presented in Table 1. The wall thickness through the blend radius of the nozzle is 6.811 inches per Table 1 of Reference [8].

In Reference [5], it is recognized that P-T limits generated for the RPV are also bounding for all portions of the reactor coolant system (RCS) piping, including the Lowest Service Temperature (LST) limits specified in NB-2332 [2]. There are at least four general reasons supporting this assumption:

1. The RPV is irradiated (thereby experiencing material degradation due to neutron embrittlement), whereas the RCS piping is not.
2. The philosophy behind the design codes used to evaluate the RPV and RCS piping generally recognize that the RPV is more limiting than the RCS piping from a structural standpoint.
3. Much of the RCS piping is austenitic stainless steel, which has ductile behavior and does not experience the same fracture concerns as the ferritic RPV.
4. Stresses are typically higher in the thicker-walled RPV than in the thin-walled RCS piping.

According to Step 6 of Section 2.0 above, the minimum temperature for normal operating conditions (Curve B) above 20% of the pre-service hydro test pressure must be greater than or equal to $RT_{NDT}$ + 120°F. The minimum temperature requirement for LST is $RT_{NDT}$ + 100°F, as defined in NB-2332 [2]. Therefore, the P-T limits in this calculation will bound the LST requirements of NB-2332. This is supported by sub-section 16.5.10 of the JAFNPP Final Safety Analysis Report [11].

## 4.0 CALCULATIONS

The P-T curves in this calculation were developed using an Excel spreadsheet, which is independently verified for use on a project-specific basis in accordance with SI's QA program. Since the verified spreadsheet only supports calculations at two EFPY values, two copies of the spreadsheet were used to develop the P-T curves at 32, 40, 48 and 54 EFPY ("P-T Curves 32 40.xls" and "P-T Curves 48 54.xls").

The polynomial stress coefficients in Table 1 were applied to Equations 4 and 8. The resulting pressure stress intensity ($K_{Ip\text{-}applied}$) and thermal stress intensity ($K_{It}$) factors are 56.17 $ksi\sqrt{inch}$ and 65.33 $ksi\sqrt{inch}$, respectively.

## 4.1 Pressure Test (Curve A)

The minimum bolt-up temperature of 60°F is applied to all regions as the initial temperature in the iterative calculation process. The static fracture toughness ($K_{Ic}$) is calculated for all regions using Equation 1. The resulting value of $K_{Ic}$, along with a safety factor of 1.5, is used in Equation 2 to calculate the pressure stress intensity ($K_{Ip}$). The allowable RPV pressure was calculated for the beltline, bottom head, and upper vessel regions using Equations 7, 8, and 9, respectively. For the feedwater nozzle / upper vessel region, the additional constraints specified in Step 6 of Section 2.0 are applied. Final P-T limits for temperature and pressure are obtained from Equations 11 and 12, respectively.

The data resulting from each P-T curve calculation was tabulated. Values for the beltline region at 32, 40, 48 and 54 EFPY are given in Table 2 through Table 5, respectively. Data for the bottom head region is listed in Table 6, and data for the feedwater nozzle / upper vessel region is presented in Table 7. The data for each region was graphed, and the resulting P-T curves for 32, 40, 48 and 54 EFPY are provided in Figure 1 through Figure 4, respectively.

## 4.2 Normal Operation – Core Not Critical (Curve B)

The minimum bolt-up temperature of 60°F is applied to all regions as the initial temperature in the iterative calculation process. The static fracture toughness ($K_{Ic}$) is calculated for all regions using Equation 1. The thermal stress intensity factor ($K_{It}$) is calculated for the beltline and bottom head regions using Equation 3, and for the feedwater nozzle using Equation 4. For the feedwater nozzle, $K_{It}$ is scaled using the iterative procedure described in the text accompanying Equations 5 and 6. When the estimated pressure is within 0.5% of the calculated pressure ($P_{P\text{-}T}$, Equation 12), the results are assumed to have satisfactorily converged.

The resulting values of $K_{Ic}$ and $K_{It}$, along with a safety factor of 2.0, are used in Equation 2 to calculate the pressure stress intensity ($K_{Ip}$). The allowable RPV pressure was calculated for the beltline, bottom head, and upper vessel regions using Equations 7, 8, and 9, respectively. For the feedwater nozzle / upper vessel region, the additional constraints specified in Step 6 of Section 2.0 are applied. Final P-T limits for temperature and pressure are obtained from Equations 11 and 12, respectively.

The data resulting from each P-T curve calculation was tabulated. Values for the beltline region at 32, 40, 48 and 54 EFPY are given in Table 8 through Table 11, respectively. Data for the bottom head region is listed in Table 12, and data for the feedwater nozzle / upper vessel region is presented in Table 13. The data for each region was graphed, and the resulting P-T curves for 32, 40, 48 and 54 EFPY are provided in Figure 5 through Figure 8, respectively.

### 4.3 Normal Operation – Core Critical (Curve C)

The pressure and temperature values for Curve C are calculated in a similar manner as Curve B, with several exceptions. The initial evaluation temperature is calculated as the limiting upper-vessel $RT_{NDT}$ (in this case, that of the closure flange region: 30°F per Section 3.0) plus 60°F, resulting in a minimum critical temperature of 90°F. When the pressure exceeds 20% of the pre-service system hydro-test pressure (20% of 1563 psig = 312 psig), the P-T limits are specified as 40°F higher than the Curve B values. The minimum temperature above the 20% pressure transition point is always greater than the reference temperature ($RT_{NDT}$) of the closure region plus 160°F, or the temperature required for the hydrostatic pressure test. The final Curve C values are taken as the absolute maximum between the three regions of Curve B P-T curves.

Tabulated overall values for Curve C are provided at 32, 40, 48 and 54 EFPY in Table 14 through Table 17, respectively. The corresponding P-T curve plots are given in Figure 9 through Figure 12, respectively.

## 5.0 CONCLUSIONS

P-T curves were calculated for JAFNPP using the methodology in Section 2.0 and the design inputs and assumptions defined in Section 3.0. A full set of P-T curves were computed, including the following plant conditions: Pressure Test (Curve A), Normal Operation – Core Not Critical (Curve B), and Normal Operation – Core Critical (Curve C). Calculations were performed for the beltline, bottom head, and feedwater nozzle / upper vessel regions. Values for the beltline regions were computed at 32, 40, 48 and 54 EFPY.

Tabulated pressure and temperature values are provided for all regions and EFPY levels in Table 2 through Table 17. The accompanying P-T curve plots are provided in Figure 1 through Figure 12.

## 6.0 REFERENCES


1. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components, 2001 Edition including the 2003 Addenda.
2. American Society of Mechanical Engineers (ASME) Boiler and Pressure vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components, Division 1, Subsection NB, "Class 1 Components," 2004 Edition.
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5. Structural Integrity Associates Report No. SIR-05-044A, Revision 0, "Pressure-Temperature Limits Report Methodology for Boiling Water Reactors," April 2007, SI File No. GE-10Q-401.
6. Structural Integrity Associates Calculation No. FITZ-10Q-301, Revision A, "Evaluation of Adjusted Reference Temperatures and Reference Temperature Shifts."
7. GE Document No. GE-NE-B1100732-01, "Plant Fitzpatrick RPV Surveillance Materials Testing and Analysis of 120° Capsule at 13.4 EFPY," Revision 1, February 1998, SI File No. FITZ-10Q-202.
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9. GE Drawing No. 729E762, Revision 1, "Reactor Thermal Cycles," SI File No. NYPA-62Q-205.
10. Combustion Engineering, Inc. Report No. CENC-1159, "Analytical Report for PASNY Reactor Vessel for Fitzpatrick Station," August 1971, SI File No. FITZ-07Q-208.
11. GE Report No. NEDC-30799-P, "James A. FitzPatrick Nuclear Power Station Feedwater Nozzle Fracture Mechanics Analysis to Show Compliance With NUREG-0619," **GE PROPRIETARY**, December 1984, SI File No. NYPA-53Q-201.
12. James A. Fitzpatrick Nuclear Power Plant Final Safety Analysis Report, Section 16.5, "Pressure Integrity of Piping and Equipment Pressure Parts," Subsection 16.5.10.

**Table 1: JAFNPP Polynomial Coefficients for Nozzle Stress Intensity Distributions**

| Feedwater Nozzle Pressure Stress Coefficients | | | |
|---|---|---|---|
| c0 | c1 | c2 | c3 |
| 40347 | -8256 | 1029 | -73 |
| **Feedwater Nozzle Thermal Stress Coefficients** | | | |
| c0 | c1 | c2 | c3 |
| 51488 | -15980 | 2002 | -127 |

## Table 2: JAFNPP Beltline Region, Curve A, for 32 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Beltline | |
| Vessel thickness, t = | 5.375 | inches |
| Vessel Radius, R = | 110.375 | inches |
| ART = | 109.6 | °F ======> 32 EFPY |
| $K_{IT}$ = | 0.00 | (no thermal effects) |
| Safety Factor = | 1.50 | |
| $M_m$ = | 2.147 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 40.89 | 27.26 | 60.0 | 0 |
| 60.0 | 40.89 | 27.26 | 60.0 | 589 |
| 62.0 | 41.20 | 27.47 | 62.0 | 593 |
| 64.0 | 41.53 | 27.69 | 64.0 | 598 |
| 66.0 | 41.87 | 27.91 | 66.0 | 603 |
| 68.0 | 42.22 | 28.15 | 68.0 | 609 |
| 70.0 | 42.59 | 28.39 | 70.0 | 614 |
| 72.0 | 42.97 | 28.65 | 72.0 | 620 |
| 74.0 | 43.37 | 28.92 | 74.0 | 626 |
| 76.0 | 43.79 | 29.19 | 76.0 | 632 |
| 78.0 | 44.22 | 29.48 | 78.0 | 639 |
| 80.0 | 44.67 | 29.78 | 80.0 | 646 |
| 82.0 | 45.14 | 30.09 | 82.0 | 653 |
| 84.0 | 45.63 | 30.42 | 84.0 | 660 |
| 86.0 | 46.13 | 30.76 | 86.0 | 668 |
| 88.0 | 46.66 | 31.11 | 88.0 | 676 |
| 90.0 | 47.21 | 31.47 | 90.0 | 684 |
| 92.0 | 47.78 | 31.85 | 92.0 | 693 |
| 94.0 | 48.38 | 32.25 | 94.0 | 702 |
| 96.0 | 49.00 | 32.66 | 96.0 | 711 |
| 98.0 | 49.64 | 33.09 | 98.0 | 721 |
| 100.0 | 50.31 | 33.54 | 100.0 | 731 |
| 102.0 | 51.01 | 34.01 | 102.0 | 742 |
| 104.0 | 51.74 | 34.49 | 104.0 | 753 |
| 106.0 | 52.49 | 35.00 | 106.0 | 764 |
| 108.0 | 53.28 | 35.52 | 108.0 | 776 |
| 110.0 | 54.10 | 36.07 | 110.0 | 788 |
| 112.0 | 54.95 | 36.64 | 112.0 | 801 |
| 114.0 | 55.84 | 37.23 | 114.0 | 815 |
| 116.0 | 56.77 | 37.84 | 116.0 | 829 |
| 118.0 | 57.73 | 38.48 | 118.0 | 843 |
| 120.0 | 58.73 | 39.15 | 120.0 | 858 |
| 122.0 | 59.77 | 39.85 | 122.0 | 874 |
| 124.0 | 60.85 | 40.57 | 124.0 | 890 |
| 126.0 | 61.98 | 41.32 | 126.0 | 908 |
| 128.0 | 63.16 | 42.10 | 128.0 | 925 |
| 130.0 | 64.38 | 42.92 | 130.0 | 944 |
| 132.0 | 65.65 | 43.77 | 132.0 | 963 |
| 134.0 | 66.98 | 44.65 | 134.0 | 983 |
| 136.0 | 68.36 | 45.57 | 136.0 | 1,004 |
| 138.0 | 69.79 | 46.53 | 138.0 | 1,026 |
| 140.0 | 71.28 | 47.52 | 140.0 | 1,048 |

## Table 2: JAFNPP Beltline Region, Curve A, for 32 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 72.84 | 48.56 | 142.0 | 1,072 |
| 144.0 | 74.46 | 49.64 | 144.0 | 1,096 |
| 146.0 | 76.14 | 50.76 | 146.0 | 1,122 |
| 148.0 | 77.89 | 51.93 | 148.0 | 1,148 |
| 150.0 | 79.72 | 53.14 | 150.0 | 1,176 |
| 152.0 | 81.61 | 54.41 | 152.0 | 1,204 |
| 154.0 | 83.59 | 55.73 | 154.0 | 1,234 |
| 156.0 | 85.65 | 57.10 | 156.0 | 1,265 |
| 158.0 | 87.79 | 58.52 | 158.0 | 1,298 |
| 160.0 | 90.01 | 60.01 | 160.0 | 1,331 |
| 162.0 | 92.33 | 61.55 | 162.0 | 1,366 |
| 164.0 | 94.75 | 63.16 | 164.0 | 1,403 |
| 166.0 | 97.26 | 64.84 | 166.0 | 1,441 |
| 168.0 | 99.87 | 66.58 | 168.0 | 1,480 |
| 170.0 | 102.59 | 68.39 | 170.0 | 1,522 |
| 172.0 | 105.42 | 70.28 | 172.0 | 1,564 |
| 174.0 | 108.37 | 72.25 | 174.0 | 1,609 |

# Table 3: JAFNPP, Beltline Region, Curve A, for 40 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Beltline | |
| Vessel thickness, t = | 5.375 | inches |
| Vessel Radius, R = | 110.375 | inches |
| ART = | 118.0 | °F ======> **40 EFPY** |
| $K_{IT}$ = | 0.00 | (no thermal effects) |
| Safety Factor = | 1.50 | |
| $M_m$ = | 2.147 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 39.70 | 26.47 | 60.0 | 0 |
| 60.0 | 39.70 | 26.47 | 60.0 | 571 |
| 62.0 | 39.97 | 26.64 | 62.0 | 575 |
| 64.0 | 40.24 | 26.83 | 64.0 | 579 |
| 66.0 | 40.53 | 27.02 | 66.0 | 583 |
| 68.0 | 40.83 | 27.22 | 68.0 | 588 |
| 70.0 | 41.14 | 27.43 | 70.0 | 592 |
| 72.0 | 41.46 | 27.64 | 72.0 | 597 |
| 74.0 | 41.80 | 27.87 | 74.0 | 602 |
| 76.0 | 42.15 | 28.10 | 76.0 | 608 |
| 78.0 | 42.52 | 28.34 | 78.0 | 613 |
| 80.0 | 42.90 | 28.60 | 80.0 | 619 |
| 82.0 | 43.29 | 28.86 | 82.0 | 625 |
| 84.0 | 43.70 | 29.14 | 84.0 | 631 |
| 86.0 | 44.13 | 29.42 | 86.0 | 638 |
| 88.0 | 44.58 | 29.72 | 88.0 | 644 |
| 90.0 | 45.04 | 30.03 | 90.0 | 651 |
| 92.0 | 45.53 | 30.35 | 92.0 | 659 |
| 94.0 | 46.03 | 30.69 | 94.0 | 666 |
| 96.0 | 46.55 | 31.04 | 96.0 | 674 |
| 98.0 | 47.10 | 31.40 | 98.0 | 682 |
| 100.0 | 47.67 | 31.78 | 100.0 | 691 |
| 102.0 | 48.26 | 32.17 | 102.0 | 700 |
| 104.0 | 48.87 | 32.58 | 104.0 | 709 |
| 106.0 | 49.51 | 33.01 | 106.0 | 719 |
| 108.0 | 50.18 | 33.45 | 108.0 | 729 |
| 110.0 | 50.87 | 33.91 | 110.0 | 739 |
| 112.0 | 51.59 | 34.39 | 112.0 | 750 |
| 114.0 | 52.34 | 34.89 | 114.0 | 762 |
| 116.0 | 53.12 | 35.41 | 116.0 | 774 |
| 118.0 | 53.93 | 35.96 | 118.0 | 786 |
| 120.0 | 54.78 | 36.52 | 120.0 | 799 |
| 122.0 | 55.66 | 37.11 | 122.0 | 812 |
| 124.0 | 56.58 | 37.72 | 124.0 | 826 |
| 126.0 | 57.53 | 38.35 | 126.0 | 840 |
| 128.0 | 58.52 | 39.02 | 128.0 | 855 |
| 130.0 | 59.56 | 39.71 | 130.0 | 871 |
| 132.0 | 60.63 | 40.42 | 132.0 | 887 |
| 134.0 | 61.75 | 41.17 | 134.0 | 904 |
| 136.0 | 62.92 | 41.95 | 136.0 | 922 |
| 138.0 | 64.13 | 42.75 | 138.0 | 940 |
| 140.0 | 65.39 | 43.60 | 140.0 | 959 |

## Table 3: JAFNPP, Beltline Region, Curve A, for 40 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 66.71 | 44.47 | 142.0 | 979 |
| 144.0 | 68.08 | 45.38 | 144.0 | 1,000 |
| 146.0 | 69.50 | 46.33 | 146.0 | 1,021 |
| 148.0 | 70.98 | 47.32 | 148.0 | 1,044 |
| 150.0 | 72.52 | 48.35 | 150.0 | 1,067 |
| 152.0 | 74.13 | 49.42 | 152.0 | 1,091 |
| 154.0 | 75.80 | 50.53 | 154.0 | 1,116 |
| 156.0 | 77.54 | 51.69 | 156.0 | 1,143 |
| 158.0 | 79.34 | 52.90 | 158.0 | 1,170 |
| 160.0 | 81.23 | 54.15 | 160.0 | 1,199 |
| 162.0 | 83.19 | 55.46 | 162.0 | 1,228 |
| 164.0 | 85.23 | 56.82 | 164.0 | 1,259 |
| 166.0 | 87.35 | 58.23 | 166.0 | 1,291 |
| 168.0 | 89.56 | 59.71 | 168.0 | 1,325 |
| 170.0 | 91.86 | 61.24 | 170.0 | 1,359 |
| 172.0 | 94.25 | 62.84 | 172.0 | 1,396 |
| 174.0 | 96.75 | 64.50 | 174.0 | 1,433 |
| 176.0 | 99.34 | 66.23 | 176.0 | 1,472 |
| 178.0 | 102.04 | 68.03 | 178.0 | 1,513 |
| 180.0 | 104.85 | 69.90 | 180.0 | 1,556 |
| 182.0 | 107.77 | 71.85 | 182.0 | 1,600 |
| 184.0 | 110.82 | 73.88 | 184.0 | 1,646 |

# Table 4: JAFNPP, Beltline Region, Curve A, for 48 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Beltline | |
| Vessel thickness, t = | 5.375 | inches |
| Vessel Radius, R = | 110.375 | inches |
| ART = | 125.5 | °F ======> 48 EFPY |
| $K_{IT}$ = | 0.00 | (no thermal effects) |
| Safety Factor = | 1.50 | |
| $M_m$ = | 2.147 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 38.79 | 25.86 | 60.0 | 0 |
| 60.0 | 38.79 | 25.86 | 60.0 | 557 |
| 62.0 | 39.02 | 26.02 | 62.0 | 560 |
| 64.0 | 39.26 | 26.17 | 64.0 | 564 |
| 66.0 | 39.51 | 26.34 | 66.0 | 568 |
| 68.0 | 39.77 | 26.51 | 68.0 | 572 |
| 70.0 | 40.03 | 26.69 | 70.0 | 576 |
| 72.0 | 40.31 | 26.87 | 72.0 | 580 |
| 74.0 | 40.60 | 27.07 | 74.0 | 584 |
| 76.0 | 40.90 | 27.27 | 76.0 | 589 |
| 78.0 | 41.22 | 27.48 | 78.0 | 594 |
| 80.0 | 41.55 | 27.70 | 80.0 | 598 |
| 82.0 | 41.89 | 27.92 | 82.0 | 604 |
| 84.0 | 42.24 | 28.16 | 84.0 | 609 |
| 86.0 | 42.61 | 28.41 | 86.0 | 615 |
| 88.0 | 42.99 | 28.66 | 88.0 | 620 |
| 90.0 | 43.39 | 28.93 | 90.0 | 626 |
| 92.0 | 43.81 | 29.21 | 92.0 | 633 |
| 94.0 | 44.24 | 29.50 | 94.0 | 639 |
| 96.0 | 44.69 | 29.80 | 96.0 | 646 |
| 98.0 | 45.16 | 30.11 | 98.0 | 653 |
| 100.0 | 45.65 | 30.43 | 100.0 | 661 |
| 102.0 | 46.16 | 30.77 | 102.0 | 668 |
| 104.0 | 46.69 | 31.13 | 104.0 | 676 |
| 106.0 | 47.24 | 31.49 | 106.0 | 685 |
| 108.0 | 47.81 | 31.87 | 108.0 | 693 |
| 110.0 | 48.41 | 32.27 | 110.0 | 702 |
| 112.0 | 49.03 | 32.69 | 112.0 | 712 |
| 114.0 | 49.67 | 33.12 | 114.0 | 721 |
| 116.0 | 50.35 | 33.56 | 116.0 | 732 |
| 118.0 | 51.05 | 34.03 | 118.0 | 742 |
| 120.0 | 51.77 | 34.52 | 120.0 | 753 |
| 122.0 | 52.53 | 35.02 | 122.0 | 765 |
| 124.0 | 53.32 | 35.55 | 124.0 | 777 |
| 126.0 | 54.14 | 36.09 | 126.0 | 789 |
| 128.0 | 55.00 | 36.66 | 128.0 | 802 |
| 130.0 | 55.89 | 37.26 | 130.0 | 815 |
| 132.0 | 56.81 | 37.87 | 132.0 | 829 |
| 134.0 | 57.78 | 38.52 | 134.0 | 844 |
| 136.0 | 58.78 | 39.19 | 136.0 | 859 |
| 138.0 | 59.82 | 39.88 | 138.0 | 875 |
| 140.0 | 60.91 | 40.61 | 140.0 | 891 |

## Table 4: JAFNPP, Beltline Region, Curve A, for 48 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 62.04 | 41.36 | 142.0 | 908 |
| 144.0 | 63.22 | 42.14 | 144.0 | 926 |
| 146.0 | 64.44 | 42.96 | 146.0 | 945 |
| 148.0 | 65.72 | 43.81 | 148.0 | 964 |
| 150.0 | 67.04 | 44.70 | 150.0 | 984 |
| 152.0 | 68.43 | 45.62 | 152.0 | 1,005 |
| 154.0 | 69.86 | 46.58 | 154.0 | 1,027 |
| 156.0 | 71.36 | 47.57 | 156.0 | 1,049 |
| 158.0 | 72.92 | 48.61 | 158.0 | 1,073 |
| 160.0 | 74.54 | 49.69 | 160.0 | 1,097 |
| 162.0 | 76.22 | 50.82 | 162.0 | 1,123 |
| 164.0 | 77.98 | 51.99 | 164.0 | 1,149 |
| 166.0 | 79.81 | 53.21 | 166.0 | 1,177 |
| 168.0 | 81.71 | 54.47 | 168.0 | 1,206 |
| 170.0 | 83.69 | 55.79 | 170.0 | 1,236 |
| 172.0 | 85.75 | 57.17 | 172.0 | 1,267 |
| 174.0 | 87.90 | 58.60 | 174.0 | 1,299 |
| 176.0 | 90.13 | 60.08 | 176.0 | 1,333 |
| 178.0 | 92.45 | 61.63 | 178.0 | 1,368 |
| 180.0 | 94.87 | 63.25 | 180.0 | 1,405 |
| 182.0 | 97.39 | 64.92 | 182.0 | 1,443 |
| 184.0 | 100.00 | 66.67 | 184.0 | 1,482 |
| 186.0 | 102.73 | 68.49 | 186.0 | 1,524 |
| 188.0 | 105.57 | 70.38 | 188.0 | 1,567 |
| 190.0 | 108.52 | 72.35 | 190.0 | 1,611 |

## Table 5: JAFNPP Beltline Region, Curve A, for 54 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Beltline | |
| Vessel thickness, t = | 5.375 | inches |
| Vessel Radius, R = | 110.375 | inches |
| ART = | 130.6 | °F ======> 54 EFPY |
| $K_{IT}$ = | 0.00 | (no thermal effects) |
| Safety Factor = | 1.50 | |
| $M_m$ = | 2.147 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 38.25 | 25.50 | 60.0 | 0 |
| 60.0 | 38.25 | 25.50 | 60.0 | 549 |
| 62.0 | 38.46 | 25.64 | 62.0 | 552 |
| 64.0 | 38.67 | 25.78 | 64.0 | 555 |
| 66.0 | 38.90 | 25.93 | 66.0 | 558 |
| 68.0 | 39.13 | 26.09 | 68.0 | 562 |
| 70.0 | 39.37 | 26.25 | 70.0 | 566 |
| 72.0 | 39.62 | 26.41 | 72.0 | 569 |
| 74.0 | 39.88 | 26.59 | 74.0 | 573 |
| 76.0 | 40.16 | 26.77 | 76.0 | 577 |
| 78.0 | 40.44 | 26.96 | 78.0 | 582 |
| 80.0 | 40.74 | 27.16 | 80.0 | 586 |
| 82.0 | 41.04 | 27.36 | 82.0 | 591 |
| 84.0 | 41.36 | 27.58 | 84.0 | 596 |
| 86.0 | 41.70 | 27.80 | 86.0 | 601 |
| 88.0 | 42.04 | 28.03 | 88.0 | 606 |
| 90.0 | 42.41 | 28.27 | 90.0 | 611 |
| 92.0 | 42.78 | 28.52 | 92.0 | 617 |
| 94.0 | 43.17 | 28.78 | 94.0 | 623 |
| 96.0 | 43.58 | 29.05 | 96.0 | 629 |
| 98.0 | 44.00 | 29.33 | 98.0 | 636 |
| 100.0 | 44.44 | 29.63 | 100.0 | 642 |
| 102.0 | 44.90 | 29.93 | 102.0 | 649 |
| 104.0 | 45.38 | 30.25 | 104.0 | 656 |
| 106.0 | 45.88 | 30.58 | 106.0 | 664 |
| 108.0 | 46.39 | 30.93 | 108.0 | 672 |
| 110.0 | 46.93 | 31.29 | 110.0 | 680 |
| 112.0 | 47.49 | 31.66 | 112.0 | 688 |
| 114.0 | 48.08 | 32.05 | 114.0 | 697 |
| 116.0 | 48.68 | 32.46 | 116.0 | 706 |
| 118.0 | 49.32 | 32.88 | 118.0 | 716 |
| 120.0 | 49.97 | 33.32 | 120.0 | 726 |
| 122.0 | 50.66 | 33.77 | 122.0 | 736 |
| 124.0 | 51.37 | 34.25 | 124.0 | 747 |
| 126.0 | 52.11 | 34.74 | 126.0 | 758 |
| 128.0 | 52.88 | 35.26 | 128.0 | 770 |
| 130.0 | 53.69 | 35.79 | 130.0 | 782 |
| 132.0 | 54.52 | 36.35 | 132.0 | 795 |
| 134.0 | 55.39 | 36.93 | 134.0 | 808 |
| 136.0 | 56.30 | 37.53 | 136.0 | 822 |
| 138.0 | 57.24 | 38.16 | 138.0 | 836 |
| 140.0 | 58.22 | 38.81 | 140.0 | 851 |

## Table 5: JAFNPP Beltline Region, Curve A, for 54 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 59.24 | 39.50 | 142.0 | 866 |
| 144.0 | 60.31 | 40.20 | 144.0 | 882 |
| 146.0 | 61.41 | 40.94 | 146.0 | 899 |
| 148.0 | 62.56 | 41.71 | 148.0 | 916 |
| 150.0 | 63.76 | 42.51 | 150.0 | 934 |
| 152.0 | 65.01 | 43.34 | 152.0 | 953 |
| 154.0 | 66.31 | 44.21 | 154.0 | 973 |
| 156.0 | 67.66 | 45.11 | 156.0 | 993 |
| 158.0 | 69.07 | 46.04 | 158.0 | 1,015 |
| 160.0 | 70.53 | 47.02 | 160.0 | 1,037 |
| 162.0 | 72.05 | 48.04 | 162.0 | 1,060 |
| 164.0 | 73.64 | 49.09 | 164.0 | 1,084 |
| 166.0 | 75.29 | 50.19 | 166.0 | 1,109 |
| 168.0 | 77.01 | 51.34 | 168.0 | 1,135 |
| 170.0 | 78.79 | 52.53 | 170.0 | 1,162 |
| 172.0 | 80.65 | 53.77 | 172.0 | 1,190 |
| 174.0 | 82.59 | 55.06 | 174.0 | 1,219 |
| 176.0 | 84.61 | 56.40 | 176.0 | 1,250 |
| 178.0 | 86.70 | 57.80 | 178.0 | 1,281 |
| 180.0 | 88.89 | 59.26 | 180.0 | 1,314 |
| 182.0 | 91.16 | 60.77 | 182.0 | 1,349 |
| 184.0 | 93.53 | 62.35 | 184.0 | 1,385 |
| 186.0 | 95.99 | 63.99 | 186.0 | 1,422 |
| 188.0 | 98.55 | 65.70 | 188.0 | 1,461 |
| 190.0 | 101.22 | 67.48 | 190.0 | 1,501 |
| 192.0 | 103.99 | 69.33 | 192.0 | 1,543 |
| 194.0 | 106.88 | 71.26 | 194.0 | 1,587 |
| 196.0 | 109.89 | 73.26 | 196.0 | 1,632 |

## Table 6: JAFNPP Bottom Head Region, Curve A, for all EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Bottom Head | (penetrations portion) |
| Bottom Head thickness, t = | 6.813 | inches |
| Bottom Head Radius, R = | 110.5 | inches |
| ART = | 10.0 | °F ======> All EFPY |
| $K_{It}$ = | 0.00 | (no thermal effects) |
| Safety Factor = | 1.50 | |
| Stress Concentration Factor = | 3.00 | (bottom head penetrations) |
| $M_m$ = | 2.417 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 89.56 | 59.71 | 60 | 0 |
| 60.0 | 89.56 | 59.71 | 60 | 987 |
| 62.0 | 91.86 | 61.24 | 62 | 1,013 |
| 64.0 | 94.25 | 62.84 | 64 | 1,040 |
| 66.0 | 96.75 | 64.50 | 66 | 1,068 |
| 68.0 | 99.34 | 66.23 | 68 | 1,098 |
| 70.0 | 102.04 | 68.03 | 70 | 1,128 |
| 72.0 | 104.85 | 69.90 | 72 | 1,160 |
| 74.0 | 107.77 | 71.85 | 74 | 1,193 |
| 76.0 | 110.82 | 73.88 | 76 | 1,228 |
| 78.0 | 113.98 | 75.99 | 78 | 1,264 |
| 80.0 | 117.28 | 78.19 | 80 | 1,301 |
| 82.0 | 120.71 | 80.47 | 82 | 1,340 |
| 84.0 | 124.28 | 82.86 | 84 | 1,381 |
| 86.0 | 128.00 | 85.33 | 86 | 1,423 |
| 88.0 | 131.87 | 87.91 | 88 | 1,467 |
| 90.0 | 135.90 | 90.60 | 90 | 1,513 |
| 92.0 | 140.09 | 93.39 | 92 | 1,560 |
| 94.0 | 144.45 | 96.30 | 94 | 1,610 |

## Table 7: JAFNPP, Upper Vessel Region, Curve A, for all EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Upper Vessel | (based on FW nozzle) |
| ART = | 20.0 | °F ======> All EFPY |
| Vessel Radius, R = | 110.375 | inches |
| Nozzle corner thickness, t' = | 6.811 | inches, approximate |
| $K_{It}$ = | 0.00 | (no thermal effects) |
| $K_{Ip\text{-}applied}$ = | 56.17 | ksi*inch$^{1/2}$ |
| Crack Depth, a = | 1.703 | inches |
| Safety Factor = | 1.50 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |
| Reference Pressure = | 1,000 | psig (pressure at which the FEA stress coeffiecients are valid) [GREEN] |
| Unit Pressure = | 1,563 | psig (hydrostatic pressure) |
| Flange $RT_{NDT}$ = | 30.0 | °F ======> All EFPY |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Ip}$ (ksi*inch$^{1/2}$) | P-T Curve Temperature (°F) | P-T Curve Pressure (psig) |
|---|---|---|---|---|
| 60.0 | 79.34 | 52.90 | 60 | 0 |
| 60.0 | 79.34 | 52.90 | 60 | 313 |
| 62.0 | 81.23 | 54.15 | 120 | 313 |
| 64.0 | 83.19 | 55.46 | 120 | 957 |
| 66.0 | 85.23 | 56.82 | 120 | 982 |
| 68.0 | 87.35 | 58.23 | 120 | 1007 |
| 70.0 | 89.56 | 59.71 | 120 | 1033 |
| 72.0 | 91.86 | 61.24 | 120 | 1060 |
| 74.0 | 94.25 | 62.84 | 120 | 1089 |
| 76.0 | 96.75 | 64.50 | 120 | 1118 |
| 78.0 | 99.34 | 66.23 | 120 | 1149 |
| 80.0 | 102.04 | 68.03 | 120 | 1181 |
| 82.0 | 104.85 | 69.90 | 120 | 1215 |
| 84.0 | 107.77 | 71.85 | 120 | 1249 |
| 86.0 | 110.82 | 73.88 | 120 | 1285 |
| 88.0 | 113.98 | 75.99 | 120 | 1323 |
| 90.0 | 117.28 | 78.19 | 120 | 1362 |
| 92.0 | 120.71 | 80.47 | 120 | 1403 |
| 94.0 | 124.28 | 82.86 | 120 | 1445 |
| 96.0 | 128.00 | 85.33 | 120 | 1489 |
| 98.0 | 131.87 | 87.91 | 120 | 1535 |
| 100.0 | 135.90 | 90.60 | 120 | 1583 |
| 102.0 | 140.09 | 93.39 | 120 | 1633 |

## Table 8: JAFNPP Beltline Region, Curve B, for 32 EFPY

| | | | |
|---|---|---|---|
| Plant = | Fitzpatrick | | |
| Component = | Beltline | | |
| Vessel thickness, t = | 5.375 | inches | |
| Vessel Radius, R = | 110.375 | inches | |
| ART = | 109.6 | °F ======> | 32 EFPY |
| $K_{It}$ = | 6.38 | ksi*inch$^{1/2}$ | |
| Safety Factor = | 2.00 | | |
| $M_m$ = | 2.147 | | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) | |
| Height of Water for a Full Vessel = | 825.20 | inches | |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) | |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) | |
| Heat Up and Cool Down Rate = | 100 | °F/Hr | |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 40.89 | 17.25 | 60.0 | 0 |
| 60.0 | 40.89 | 17.25 | 60.0 | 362 |
| 62.0 | 41.20 | 17.41 | 62.0 | 365 |
| 64.0 | 41.53 | 17.57 | 64.0 | 369 |
| 66.0 | 41.87 | 17.74 | 66.0 | 373 |
| 68.0 | 42.22 | 17.92 | 68.0 | 377 |
| 70.0 | 42.59 | 18.10 | 70.0 | 381 |
| 72.0 | 42.97 | 18.30 | 72.0 | 385 |
| 74.0 | 43.37 | 18.50 | 74.0 | 390 |
| 76.0 | 43.79 | 18.70 | 76.0 | 394 |
| 78.0 | 44.22 | 18.92 | 78.0 | 399 |
| 80.0 | 44.67 | 19.14 | 80.0 | 404 |
| 82.0 | 45.14 | 19.38 | 82.0 | 410 |
| 84.0 | 45.63 | 19.62 | 84.0 | 415 |
| 86.0 | 46.13 | 19.87 | 86.0 | 421 |
| 88.0 | 46.66 | 20.14 | 88.0 | 427 |
| 90.0 | 47.21 | 20.41 | 90.0 | 433 |
| 92.0 | 47.78 | 20.70 | 92.0 | 440 |
| 94.0 | 48.38 | 21.00 | 94.0 | 446 |
| 96.0 | 49.00 | 21.31 | 96.0 | 454 |
| 98.0 | 49.64 | 21.63 | 98.0 | 461 |
| 100.0 | 50.31 | 21.96 | 100.0 | 468 |
| 102.0 | 51.01 | 22.31 | 102.0 | 476 |
| 104.0 | 51.74 | 22.68 | 104.0 | 485 |
| 106.0 | 52.49 | 23.06 | 106.0 | 493 |
| 108.0 | 53.28 | 23.45 | 108.0 | 502 |
| 110.0 | 54.10 | 23.86 | 110.0 | 511 |
| 112.0 | 54.95 | 24.29 | 112.0 | 521 |
| 114.0 | 55.84 | 24.73 | 114.0 | 531 |
| 116.0 | 56.77 | 25.19 | 116.0 | 542 |
| 118.0 | 57.73 | 25.67 | 118.0 | 553 |
| 120.0 | 58.73 | 26.17 | 120.0 | 564 |
| 122.0 | 59.77 | 26.69 | 122.0 | 576 |
| 124.0 | 60.85 | 27.24 | 124.0 | 588 |
| 126.0 | 61.98 | 27.80 | 126.0 | 601 |
| 128.0 | 63.16 | 28.39 | 128.0 | 614 |
| 130.0 | 64.38 | 29.00 | 130.0 | 628 |
| 132.0 | 65.65 | 29.63 | 132.0 | 642 |
| 134.0 | 66.98 | 30.30 | 134.0 | 657 |
| 136.0 | 68.36 | 30.99 | 136.0 | 673 |
| 138.0 | 69.79 | 31.70 | 138.0 | 689 |
| 140.0 | 71.28 | 32.45 | 140.0 | 706 |

## Table 8: JAFNPP Beltline Region, Curve B, for 32 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 72.84 | 33.23 | 142.0 | 724 |
| 144.0 | 74.46 | 34.04 | 144.0 | 742 |
| 146.0 | 76.14 | 34.88 | 146.0 | 761 |
| 148.0 | 77.89 | 35.75 | 148.0 | 781 |
| 150.0 | 79.72 | 36.67 | 150.0 | 802 |
| 152.0 | 81.61 | 37.62 | 152.0 | 823 |
| 154.0 | 83.59 | 38.60 | 154.0 | 846 |
| 156.0 | 85.65 | 39.63 | 156.0 | 869 |
| 158.0 | 87.79 | 40.70 | 158.0 | 893 |
| 160.0 | 90.01 | 41.82 | 160.0 | 919 |
| 162.0 | 92.33 | 42.97 | 162.0 | 945 |
| 164.0 | 94.75 | 44.18 | 164.0 | 972 |
| 166.0 | 97.26 | 45.44 | 166.0 | 1,001 |
| 168.0 | 99.87 | 46.74 | 168.0 | 1,031 |
| 170.0 | 102.59 | 48.10 | 170.0 | 1,061 |
| 172.0 | 105.42 | 49.52 | 172.0 | 1,093 |
| 174.0 | 108.37 | 50.99 | 174.0 | 1,127 |
| 176.0 | 111.44 | 52.53 | 176.0 | 1,162 |
| 178.0 | 114.63 | 54.12 | 178.0 | 1,198 |
| 180.0 | 117.96 | 55.79 | 180.0 | 1,236 |
| 182.0 | 121.41 | 57.52 | 182.0 | 1,275 |
| 184.0 | 125.01 | 59.32 | 184.0 | 1,316 |
| 186.0 | 128.76 | 61.19 | 186.0 | 1,358 |
| 188.0 | 132.66 | 63.14 | 188.0 | 1,402 |
| 190.0 | 136.72 | 65.17 | 190.0 | 1,448 |
| 192.0 | 140.95 | 67.28 | 192.0 | 1,496 |
| 194.0 | 145.34 | 69.48 | 194.0 | 1,546 |
| 196.0 | 149.92 | 71.77 | 196.0 | 1,598 |
| 198.0 | 154.68 | 74.15 | 198.0 | 1,652 |

# Table 9: JAFNPP Beltline Region, Curve B, for 40 EFPY

| | | | |
|---|---|---|---|
| Plant = | Fitzpatrick | | |
| Component = | Beltline | | |
| Vessel thickness, t = | 5.375 | inches | |
| Vessel Radius, R = | 110.375 | inches | |
| ART = | 118.0 | °F ======> | 40 EFPY |
| $K_{It}$ = | 6.38 | ksi*inch$^{1/2}$ | |
| Safety Factor = | 2.00 | | |
| $M_m$ = | 2.147 | | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) | |
| Height of Water for a Full Vessel = | 825.20 | inches | |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) | |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) | |
| Heat Up and Cool Down Rate = | 100 | °F/Hr | |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 39.70 | 16.66 | 60.0 | 0 |
| 60.0 | 39.70 | 16.66 | 60.0 | 348 |
| 62.0 | 39.97 | 16.79 | 62.0 | 351 |
| 64.0 | 40.24 | 16.93 | 64.0 | 354 |
| 66.0 | 40.53 | 17.07 | 66.0 | 357 |
| 68.0 | 40.83 | 17.22 | 68.0 | 361 |
| 70.0 | 41.14 | 17.38 | 70.0 | 364 |
| 72.0 | 41.46 | 17.54 | 72.0 | 368 |
| 74.0 | 41.80 | 17.71 | 74.0 | 372 |
| 76.0 | 42.15 | 17.88 | 76.0 | 376 |
| 78.0 | 42.52 | 18.07 | 78.0 | 380 |
| 80.0 | 42.90 | 18.26 | 80.0 | 384 |
| 82.0 | 43.29 | 18.45 | 82.0 | 389 |
| 84.0 | 43.70 | 18.66 | 84.0 | 393 |
| 86.0 | 44.13 | 18.87 | 86.0 | 398 |
| 88.0 | 44.58 | 19.10 | 88.0 | 403 |
| 90.0 | 45.04 | 19.33 | 90.0 | 409 |
| 92.0 | 45.53 | 19.57 | 92.0 | 414 |
| 94.0 | 46.03 | 19.82 | 94.0 | 420 |
| 96.0 | 46.55 | 20.09 | 96.0 | 426 |
| 98.0 | 47.10 | 20.36 | 98.0 | 432 |
| 100.0 | 47.67 | 20.64 | 100.0 | 438 |
| 102.0 | 48.26 | 20.94 | 102.0 | 445 |
| 104.0 | 48.87 | 21.24 | 104.0 | 452 |
| 106.0 | 49.51 | 21.56 | 106.0 | 459 |
| 108.0 | 50.18 | 21.90 | 108.0 | 467 |
| 110.0 | 50.87 | 22.24 | 110.0 | 475 |
| 112.0 | 51.59 | 22.60 | 112.0 | 483 |
| 114.0 | 52.34 | 22.98 | 114.0 | 491 |
| 116.0 | 53.12 | 23.37 | 116.0 | 500 |
| 118.0 | 53.93 | 23.78 | 118.0 | 510 |
| 120.0 | 54.78 | 24.20 | 120.0 | 519 |
| 122.0 | 55.66 | 24.64 | 122.0 | 529 |
| 124.0 | 56.58 | 25.10 | 124.0 | 539 |
| 126.0 | 57.53 | 25.57 | 126.0 | 550 |
| 128.0 | 58.52 | 26.07 | 128.0 | 562 |
| 130.0 | 59.56 | 26.59 | 130.0 | 573 |
| 132.0 | 60.63 | 27.13 | 132.0 | 585 |
| 134.0 | 61.75 | 27.69 | 134.0 | 598 |
| 136.0 | 62.92 | 28.27 | 136.0 | 611 |
| 138.0 | 64.13 | 28.87 | 138.0 | 625 |
| 140.0 | 65.39 | 29.51 | 140.0 | 639 |

## Table 9: JAFNPP Beltline Region, Curve B, for 40 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 66.71 | 30.16 | 142.0 | 654 |
| 144.0 | 68.08 | 30.85 | 144.0 | 670 |
| 146.0 | 69.50 | 31.56 | 146.0 | 686 |
| 148.0 | 70.98 | 32.30 | 148.0 | 703 |
| 150.0 | 72.52 | 33.07 | 150.0 | 720 |
| 152.0 | 74.13 | 33.87 | 152.0 | 739 |
| 154.0 | 75.80 | 34.71 | 154.0 | 757 |
| 156.0 | 77.54 | 35.58 | 156.0 | 777 |
| 158.0 | 79.34 | 36.48 | 158.0 | 798 |
| 160.0 | 81.23 | 37.42 | 160.0 | 819 |
| 162.0 | 83.19 | 38.40 | 162.0 | 841 |
| 164.0 | 85.23 | 39.42 | 164.0 | 864 |
| 166.0 | 87.35 | 40.48 | 166.0 | 889 |
| 168.0 | 89.56 | 41.59 | 168.0 | 914 |
| 170.0 | 91.86 | 42.74 | 170.0 | 940 |
| 172.0 | 94.25 | 43.94 | 172.0 | 967 |
| 174.0 | 96.75 | 45.18 | 174.0 | 995 |
| 176.0 | 99.34 | 46.48 | 176.0 | 1,024 |
| 178.0 | 102.04 | 47.83 | 178.0 | 1,055 |
| 180.0 | 104.85 | 49.23 | 180.0 | 1,087 |
| 182.0 | 107.77 | 50.69 | 182.0 | 1,120 |
| 184.0 | 110.82 | 52.22 | 184.0 | 1,155 |
| 186.0 | 113.98 | 53.80 | 186.0 | 1,191 |
| 188.0 | 117.28 | 55.45 | 188.0 | 1,228 |
| 190.0 | 120.71 | 57.16 | 190.0 | 1,267 |
| 192.0 | 124.28 | 58.95 | 192.0 | 1,307 |
| 194.0 | 128.00 | 60.81 | 194.0 | 1,350 |
| 196.0 | 131.87 | 62.74 | 196.0 | 1,393 |
| 198.0 | 135.90 | 64.76 | 198.0 | 1,439 |
| 200.0 | 140.09 | 66.85 | 200.0 | 1,487 |
| 202.0 | 144.45 | 69.03 | 202.0 | 1,536 |
| 204.0 | 148.99 | 71.30 | 204.0 | 1,588 |
| 206.0 | 153.72 | 73.67 | 206.0 | 1,641 |

# Table 10: JAFNPP Beltline Region, Curve B, for 48 EFPY

| | | | |
|---|---|---|---|
| Plant = | Fitzpatrick | | |
| Component = | Beltline | | |
| Vessel thickness, t = | 5.375 | inches | |
| Vessel Radius, R = | 110.375 | inches | |
| ART = | 125.5 | °F ======> | 48 EFPY |
| $K_{It}$ = | 6.38 | ksi*inch$^{1/2}$ | |
| Safety Factor = | 2.00 | | |
| $M_m$ = | 2.147 | | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) | |
| Height of Water for a Full Vessel = | 825.20 | inches | |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) | |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) | |
| Heat Up and Cool Down Rate = | 100 | °F/Hr | |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 38.79 | 16.21 | 60.0 | 0 |
| 60.0 | 38.79 | 16.21 | 60.0 | 338 |
| 62.0 | 39.02 | 16.32 | 62.0 | 340 |
| 64.0 | 39.26 | 16.44 | 64.0 | 343 |
| 66.0 | 39.51 | 16.56 | 66.0 | 346 |
| 68.0 | 39.77 | 16.69 | 68.0 | 349 |
| 70.0 | 40.03 | 16.82 | 70.0 | 352 |
| 72.0 | 40.31 | 16.96 | 72.0 | 355 |
| 74.0 | 40.60 | 17.11 | 74.0 | 358 |
| 76.0 | 40.90 | 17.26 | 76.0 | 362 |
| 78.0 | 41.22 | 17.42 | 78.0 | 365 |
| 80.0 | 41.55 | 17.58 | 80.0 | 369 |
| 82.0 | 41.89 | 17.75 | 82.0 | 373 |
| 84.0 | 42.24 | 17.93 | 84.0 | 377 |
| 86.0 | 42.61 | 18.11 | 86.0 | 381 |
| 88.0 | 42.99 | 18.31 | 88.0 | 385 |
| 90.0 | 43.39 | 18.51 | 90.0 | 390 |
| 92.0 | 43.81 | 18.71 | 92.0 | 395 |
| 94.0 | 44.24 | 18.93 | 94.0 | 400 |
| 96.0 | 44.69 | 19.16 | 96.0 | 405 |
| 98.0 | 45.16 | 19.39 | 98.0 | 410 |
| 100.0 | 45.65 | 19.63 | 100.0 | 416 |
| 102.0 | 46.16 | 19.89 | 102.0 | 421 |
| 104.0 | 46.69 | 20.15 | 104.0 | 427 |
| 106.0 | 47.24 | 20.43 | 106.0 | 434 |
| 108.0 | 47.81 | 20.71 | 108.0 | 440 |
| 110.0 | 48.41 | 21.01 | 110.0 | 447 |
| 112.0 | 49.03 | 21.32 | 112.0 | 454 |
| 114.0 | 49.67 | 21.65 | 114.0 | 461 |
| 116.0 | 50.35 | 21.98 | 116.0 | 469 |
| 118.0 | 51.05 | 22.33 | 118.0 | 477 |
| 120.0 | 51.77 | 22.70 | 120.0 | 485 |
| 122.0 | 52.53 | 23.07 | 122.0 | 494 |
| 124.0 | 53.32 | 23.47 | 124.0 | 503 |
| 126.0 | 54.14 | 23.88 | 126.0 | 512 |
| 128.0 | 55.00 | 24.31 | 128.0 | 522 |
| 130.0 | 55.89 | 24.75 | 130.0 | 532 |
| 132.0 | 56.81 | 25.21 | 132.0 | 542 |
| 134.0 | 57.78 | 25.70 | 134.0 | 553 |
| 136.0 | 58.78 | 26.20 | 136.0 | 564 |
| 138.0 | 59.82 | 26.72 | 138.0 | 576 |
| 140.0 | 60.91 | 27.26 | 140.0 | 589 |

## Table 10: JAFNPP Beltline Region, Curve B, for 48 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 62.04 | 27.83 | 142.0 | 601 |
| 144.0 | 63.22 | 28.42 | 144.0 | 615 |
| 146.0 | 64.44 | 29.03 | 146.0 | 629 |
| 148.0 | 65.72 | 29.67 | 148.0 | 643 |
| 150.0 | 67.04 | 30.33 | 150.0 | 658 |
| 152.0 | 68.43 | 31.02 | 152.0 | 674 |
| 154.0 | 69.86 | 31.74 | 154.0 | 690 |
| 156.0 | 71.36 | 32.49 | 156.0 | 707 |
| 158.0 | 72.92 | 33.27 | 158.0 | 725 |
| 160.0 | 74.54 | 34.08 | 160.0 | 743 |
| 162.0 | 76.22 | 34.92 | 162.0 | 762 |
| 164.0 | 77.98 | 35.80 | 164.0 | 782 |
| 166.0 | 79.81 | 36.71 | 166.0 | 803 |
| 168.0 | 81.71 | 37.66 | 168.0 | 825 |
| 170.0 | 83.69 | 38.65 | 170.0 | 847 |
| 172.0 | 85.75 | 39.68 | 172.0 | 870 |
| 174.0 | 87.90 | 40.76 | 174.0 | 895 |
| 176.0 | 90.13 | 41.87 | 176.0 | 920 |
| 178.0 | 92.45 | 43.03 | 178.0 | 946 |
| 180.0 | 94.87 | 44.24 | 180.0 | 974 |
| 182.0 | 97.39 | 45.50 | 182.0 | 1,002 |
| 184.0 | 100.00 | 46.81 | 184.0 | 1,032 |
| 186.0 | 102.73 | 48.17 | 186.0 | 1,063 |
| 188.0 | 105.57 | 49.59 | 188.0 | 1,095 |
| 190.0 | 108.52 | 51.07 | 190.0 | 1,129 |
| 192.0 | 111.60 | 52.61 | 192.0 | 1,163 |
| 194.0 | 114.80 | 54.21 | 194.0 | 1,200 |
| 196.0 | 118.13 | 55.87 | 196.0 | 1,238 |
| 198.0 | 121.59 | 57.60 | 198.0 | 1,277 |
| 200.0 | 125.20 | 59.41 | 200.0 | 1,318 |
| 202.0 | 128.95 | 61.29 | 202.0 | 1,360 |
| 204.0 | 132.86 | 63.24 | 204.0 | 1,405 |
| 206.0 | 136.93 | 65.27 | 206.0 | 1,451 |
| 208.0 | 141.16 | 67.39 | 208.0 | 1,499 |
| 210.0 | 145.57 | 69.59 | 210.0 | 1,549 |
| 212.0 | 150.15 | 71.89 | 212.0 | 1,601 |

## Table 11: JAFNPP Beltline Region, Curve B, for 54 EFPY

| | | | |
|---|---|---|---|
| Plant = | Fitzpatrick | | |
| Component = | Beltline | | |
| Vessel thickness, t = | 5.375 | inches | |
| Vessel Radius, R = | 110.375 | inches | |
| ART = | 130.6 | °F ======> | 54 EFPY |
| $K_{It}$ = | 6.38 | ksi*inch$^{1/2}$ | |
| Safety Factor = | 2.00 | | |
| $M_m$ = | 2.147 | | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) | |
| Height of Water for a Full Vessel = | 825.20 | inches | |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) | |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) | |
| Heat Up and Cool Down Rate = | 100 | °F/Hr | |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 38.25 | 15.93 | 60.0 | 0 |
| 60.0 | 38.25 | 15.93 | 60.0 | 332 |
| 62.0 | 38.46 | 16.04 | 62.0 | 334 |
| 64.0 | 38.67 | 16.14 | 64.0 | 336 |
| 66.0 | 38.90 | 16.26 | 66.0 | 339 |
| 68.0 | 39.13 | 16.37 | 68.0 | 342 |
| 70.0 | 39.37 | 16.49 | 70.0 | 344 |
| 72.0 | 39.62 | 16.62 | 72.0 | 347 |
| 74.0 | 39.88 | 16.75 | 74.0 | 350 |
| 76.0 | 40.16 | 16.89 | 76.0 | 353 |
| 78.0 | 40.44 | 17.03 | 78.0 | 356 |
| 80.0 | 40.74 | 17.18 | 80.0 | 360 |
| 82.0 | 41.04 | 17.33 | 82.0 | 363 |
| 84.0 | 41.36 | 17.49 | 84.0 | 367 |
| 86.0 | 41.70 | 17.66 | 86.0 | 371 |
| 88.0 | 42.04 | 17.83 | 88.0 | 375 |
| 90.0 | 42.41 | 18.01 | 90.0 | 379 |
| 92.0 | 42.78 | 18.20 | 92.0 | 383 |
| 94.0 | 43.17 | 18.39 | 94.0 | 387 |
| 96.0 | 43.58 | 18.60 | 96.0 | 392 |
| 98.0 | 44.00 | 18.81 | 98.0 | 397 |
| 100.0 | 44.44 | 19.03 | 100.0 | 402 |
| 102.0 | 44.90 | 19.26 | 102.0 | 407 |
| 104.0 | 45.38 | 19.50 | 104.0 | 412 |
| 106.0 | 45.88 | 19.75 | 106.0 | 418 |
| 108.0 | 46.39 | 20.01 | 108.0 | 424 |
| 110.0 | 46.93 | 20.27 | 110.0 | 430 |
| 112.0 | 47.49 | 20.55 | 112.0 | 436 |
| 114.0 | 48.08 | 20.85 | 114.0 | 443 |
| 116.0 | 48.68 | 21.15 | 116.0 | 450 |
| 118.0 | 49.32 | 21.47 | 118.0 | 457 |
| 120.0 | 49.97 | 21.79 | 120.0 | 465 |
| 122.0 | 50.66 | 22.14 | 122.0 | 472 |
| 124.0 | 51.37 | 22.49 | 124.0 | 480 |
| 126.0 | 52.11 | 22.86 | 126.0 | 489 |
| 128.0 | 52.88 | 23.25 | 128.0 | 498 |
| 130.0 | 53.69 | 23.65 | 130.0 | 507 |
| 132.0 | 54.52 | 24.07 | 132.0 | 516 |
| 134.0 | 55.39 | 24.50 | 134.0 | 526 |
| 136.0 | 56.30 | 24.96 | 136.0 | 536 |
| 138.0 | 57.24 | 25.43 | 138.0 | 547 |
| 140.0 | 58.22 | 25.92 | 140.0 | 558 |

## Table 11: JAFNPP Beltline Region, Curve B, for 54 EFPY (continued)

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 142.0 | 59.24 | 26.43 | 142.0 | 570 |
| 144.0 | 60.31 | 26.96 | 144.0 | 582 |
| 146.0 | 61.41 | 27.51 | 146.0 | 594 |
| 148.0 | 62.56 | 28.09 | 148.0 | 607 |
| 150.0 | 63.76 | 28.69 | 150.0 | 621 |
| 152.0 | 65.01 | 29.31 | 152.0 | 635 |
| 154.0 | 66.31 | 29.96 | 154.0 | 650 |
| 156.0 | 67.66 | 30.64 | 156.0 | 665 |
| 158.0 | 69.07 | 31.34 | 158.0 | 681 |
| 160.0 | 70.53 | 32.07 | 160.0 | 698 |
| 162.0 | 72.05 | 32.83 | 162.0 | 715 |
| 164.0 | 73.64 | 33.63 | 164.0 | 733 |
| 166.0 | 75.29 | 34.45 | 166.0 | 752 |
| 168.0 | 77.01 | 35.31 | 168.0 | 771 |
| 170.0 | 78.79 | 36.21 | 170.0 | 791 |
| 172.0 | 80.65 | 37.14 | 172.0 | 813 |
| 174.0 | 82.59 | 38.10 | 174.0 | 835 |
| 176.0 | 84.61 | 39.11 | 176.0 | 857 |
| 178.0 | 86.70 | 40.16 | 178.0 | 881 |
| 180.0 | 88.89 | 41.25 | 180.0 | 906 |
| 182.0 | 91.16 | 42.39 | 182.0 | 932 |
| 184.0 | 93.53 | 43.57 | 184.0 | 959 |
| 186.0 | 95.99 | 44.80 | 186.0 | 986 |
| 188.0 | 98.55 | 46.08 | 188.0 | 1,016 |
| 190.0 | 101.22 | 47.42 | 190.0 | 1,046 |
| 192.0 | 103.99 | 48.81 | 192.0 | 1,077 |
| 194.0 | 106.88 | 50.25 | 194.0 | 1,110 |
| 196.0 | 109.89 | 51.75 | 196.0 | 1,144 |
| 198.0 | 113.02 | 53.32 | 198.0 | 1,180 |
| 200.0 | 116.28 | 54.95 | 200.0 | 1,217 |
| 202.0 | 119.67 | 56.64 | 202.0 | 1,255 |
| 204.0 | 123.20 | 58.41 | 204.0 | 1,295 |
| 206.0 | 126.87 | 60.24 | 206.0 | 1,337 |
| 208.0 | 130.69 | 62.15 | 208.0 | 1,380 |
| 210.0 | 134.67 | 64.14 | 210.0 | 1,425 |
| 212.0 | 138.81 | 66.21 | 212.0 | 1,472 |
| 214.0 | 143.12 | 68.37 | 214.0 | 1,521 |
| 216.0 | 147.61 | 70.61 | 216.0 | 1,572 |
| 218.0 | 152.28 | 72.95 | 218.0 | 1,625 |

## Table 12: JAFNPP Bottom Head Region, Curve B, for all EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Bottom Head | (penetrations portion) |
| Bottom Head thickness, t = | 6.813 | inches |
| Bottom Head Radius, R = | 110.5 | inches |
| ART = | 10.0 | °F ======> All EFPY |
| $K_{It}$ = | 11.54 | ksi*inch$^{1/2}$ |
| Safety Factor = | 2.00 | |
| Stress Concentration Factor = | 3.00 | (bottom head penetrations) |
| $M_m$ = | 2.417 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |
| Heat Up and Cool Down Rate = | 100 | °F/Hr |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Im}$ (ksi*inch$^{1/2}$) | Temperature for P-T Curve (°F) | Adjusted Pressure for P-T Curve (psig) |
|---|---|---|---|---|
| 60.0 | 89.56 | 39.01 | 60 | 0 |
| 60.0 | 89.56 | 39.01 | 60 | 634 |
| 62.0 | 91.86 | 40.16 | 62 | 654 |
| 64.0 | 94.25 | 41.36 | 64 | 674 |
| 66.0 | 96.75 | 42.60 | 66 | 695 |
| 68.0 | 99.34 | 43.90 | 68 | 718 |
| 70.0 | 102.04 | 45.25 | 70 | 741 |
| 72.0 | 104.85 | 46.65 | 72 | 764 |
| 74.0 | 107.77 | 48.11 | 74 | 789 |
| 76.0 | 110.82 | 49.64 | 76 | 815 |
| 78.0 | 113.98 | 51.22 | 78 | 842 |
| 80.0 | 117.28 | 52.87 | 80 | 870 |
| 82.0 | 120.71 | 54.58 | 82 | 899 |
| 84.0 | 124.28 | 56.37 | 84 | 930 |
| 86.0 | 128.00 | 58.23 | 86 | 962 |
| 88.0 | 131.87 | 60.16 | 88 | 994 |
| 90.0 | 135.90 | 62.18 | 90 | 1,029 |
| 92.0 | 140.09 | 64.27 | 92 | 1,064 |
| 94.0 | 144.45 | 66.45 | 94 | 1,102 |
| 96.0 | 148.99 | 68.72 | 96 | 1,140 |
| 98.0 | 153.72 | 71.09 | 98 | 1,180 |
| 100.0 | 158.63 | 73.54 | 100 | 1,222 |
| 102.0 | 163.75 | 76.10 | 102 | 1,266 |
| 104.0 | 169.08 | 78.77 | 104 | 1,311 |
| 106.0 | 174.63 | 81.54 | 106 | 1,358 |
| 108.0 | 180.40 | 84.43 | 108 | 1,408 |
| 110.0 | 186.40 | 87.43 | 110 | 1,459 |
| 112.0 | 192.66 | 90.56 | 112 | 1,512 |
| 114.0 | 199.16 | 93.81 | 114 | 1,567 |
| 116.0 | 205.94 | 97.20 | 116 | 1,625 |

# Table 13: JAFNPP Upper Vessel Region, Curve B, for all EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Component = | Upper Vessel | (based on FW nozzle) |
| ART = | 20.0 | °F ======> All EFPY |
| Vessel Radius, R = | 110.375 | inches |
| Nozzle corner thickness, t = | 6.811 | inches, approximate |
| $K_{It}$ = | 65.32 | ksi*inch$^{1/2}$ |
| $K_{Ip\text{-}applied}$ = | 56.17 | ksi*inch$^{1/2}$ |
| Crack Depth, a = | 1.703 | inches |
| Safety Factor = | 2.00 | |
| Temperature Adjustment = | 0.0 | °F (applied after bolt-up, instrument uncertainty) |
| Height of Water for a Full Vessel = | 825.20 | inches |
| Pressure Adjustment = | 29.8 | psig (hydrostatic pressure head for a full vessel at 70°F) |
| Pressure Adjustment = | 0.0 | psig (instrument uncertainty) |
| Reference Pressure = | 1,000 | psig (pressure at which the FEA stress coeffiecients are valid) [GREEN] |
| Unit Pressure = | 1,563 | psig (hydrostatic pressure) |
| Flange $RT_{NDT}$ = | 30.0 | °F ======> All EFPY |

| Gauge Fluid Temperature (°F) | $K_{Ic}$ (ksi*inch$^{1/2}$) | $K_{Ip}$ (ksi*inch$^{1/2}$) | P-T Curve Temperature (°F) | P-T Curve Pressure (psig) |
|---|---|---|---|---|
| 60.0 | 79.34 | 7.01 | 60 | 0 |
| 60.0 | 79.34 | 17.19 | 60 | 276 |
| 62.0 | 81.23 | 17.86 | 62 | 288 |
| 64.0 | 83.19 | 18.55 | 64 | 301 |
| 66.0 | 85.23 | 19.31 | 64 | 313 |
| 68.0 | 87.35 | 20.37 | 150 | 313 |
| 70.0 | 89.56 | 20.87 | 150 | 342 |
| 72.0 | 91.86 | 21.72 | 150 | 357 |
| 74.0 | 94.25 | 22.62 | 150 | 373 |
| 76.0 | 96.75 | 23.55 | 150 | 389 |
| 78.0 | 99.34 | 24.53 | 150 | 407 |
| 80.0 | 102.04 | 25.57 | 150 | 425 |
| 82.0 | 104.85 | 26.65 | 150 | 445 |
| 84.0 | 107.77 | 27.79 | 150 | 465 |
| 86.0 | 110.82 | 28.98 | 150 | 486 |
| 88.0 | 113.98 | 30.24 | 150 | 508 |
| 90.0 | 117.28 | 31.55 | 150 | 532 |
| 92.0 | 120.71 | 32.91 | 150 | 556 |
| 94.0 | 124.28 | 34.35 | 150 | 582 |
| 96.0 | 128.00 | 35.86 | 150 | 609 |
| 98.0 | 131.87 | 37.45 | 150 | 637 |
| 100.0 | 135.90 | 39.10 | 150 | 666 |
| 102.0 | 140.09 | 40.84 | 150 | 697 |
| 104.0 | 144.45 | 42.65 | 150 | 730 |
| 106.0 | 148.99 | 44.56 | 150 | 763 |
| 108.0 | 153.72 | 46.55 | 150 | 799 |
| 110.0 | 158.63 | 48.62 | 150 | 836 |
| 112.0 | 163.75 | 50.80 | 150 | 875 |
| 114.0 | 169.08 | 53.08 | 150 | 915 |
| 116.0 | 174.63 | 55.46 | 150 | 958 |
| 118.0 | 180.40 | 57.96 | 150 | 1002 |
| 120.0 | 186.40 | 60.57 | 150 | 1048 |
| 122.0 | 192.66 | 63.30 | 150 | 1097 |
| 124.0 | 199.16 | 66.15 | 150 | 1148 |
| 126.0 | 205.94 | 69.13 | 150 | 1201 |
| 128.0 | 212.99 | 72.25 | 150 | 1256 |
| 130.0 | 220.32 | 75.50 | 150 | 1314 |
| 132.0 | 227.96 | 78.89 | 150 | 1375 |
| 134.0 | 235.91 | 82.45 | 150 | 1438 |
| 136.0 | 244.18 | 86.16 | 150 | 1504 |
| 138.0 | 252.79 | 90.04 | 150 | 1573 |
| 140.0 | 261.75 | 94.08 | 150 | 1645 |

## Table 14: JAFNPP Curve C Values for 32 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Curve A Leak Test Temperature = | 138.0 | °F |
| Curve A Pressure = | 1,025.0 | psig |
| Unit Pressure = | 1,563 | psig (hydrostatic pressure) |
| Flange $RT_{NDT}$ = | 30.0 | °F |

| Adjusted P-T Curve Temperature | Adjusted P-T Curve Pressure |
|---|---|
| 90.00 | 0 |
| 90.00 | 50 |
| 90.00 | 100 |
| 90.00 | 150 |
| 90.00 | 200 |
| 95.17 | 250 |
| 103.92 | 300 |
| 104.00 | 312 |
| 190.00 | 313 |
| 190.00 | 350 |
| 190.00 | 400 |
| 190.00 | 450 |
| 190.00 | 500 |
| 190.00 | 550 |
| 190.00 | 600 |
| 190.00 | 650 |
| 190.00 | 700 |
| 190.00 | 750 |
| 190.00 | 800 |
| 194.36 | 850 |
| 198.52 | 900 |
| 202.36 | 950 |
| 205.94 | 1000 |
| 209.26 | 1050 |
| 212.39 | 1100 |
| 215.33 | 1150 |
| 218.11 | 1200 |
| 220.73 | 1250 |
| 223.23 | 1300 |
| 225.61 | 1350 |
| 227.89 | 1400 |
| 230.06 | 1450 |
| 232.15 | 1500 |
| 234.14 | 1550 |
| 236.07 | 1600 |

## Table 15: JAFNPP Curve C Values for 40 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Curve A Leak Test Temperature = | 148.0 | °F |
| Curve A Pressure = | 1,025.0 | psig |
| Unit Pressure = | 1,563 | psig (hydrostatic pressure) |
| Flange $RT_{NDT}$ = | 30.0 | °F |

| Adjusted P-T Curve Temperature | Adjusted P-T Curve Pressure |
|---|---|
| 90.00 | 0 |
| 90.00 | 50 |
| 90.00 | 100 |
| 90.00 | 150 |
| 90.00 | 200 |
| 95.17 | 250 |
| 103.92 | 300 |
| 104.00 | 312 |
| 190.00 | 313 |
| 190.00 | 350 |
| 190.00 | 400 |
| 190.00 | 450 |
| 190.00 | 500 |
| 190.00 | 550 |
| 190.00 | 600 |
| 190.00 | 650 |
| 190.00 | 700 |
| 193.21 | 750 |
| 198.22 | 800 |
| 202.75 | 850 |
| 206.92 | 900 |
| 210.76 | 950 |
| 214.33 | 1000 |
| 217.67 | 1050 |
| 220.79 | 1100 |
| 223.73 | 1150 |
| 226.50 | 1200 |
| 229.13 | 1250 |
| 231.64 | 1300 |
| 234.02 | 1350 |
| 236.29 | 1400 |
| 238.46 | 1450 |
| 240.54 | 1500 |
| 242.54 | 1550 |
| 244.48 | 1600 |

## Table 16: JAFNPP Curve C Values for 48 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Curve A Leak Test Temperature = | 154.0 | °F |
| Curve A Pressure = | 1,025.0 | psig |
| Unit Pressure = | 1,563 | psig (hydrostatic pressure) |
| Flange $RT_{NDT}$ = | 30.0 | °F |

| Adjusted P-T Curve Temperature | Adjusted P-T Curve Pressure |
|---|---|
| 90.00 | 0 |
| 90.00 | 50 |
| 90.00 | 100 |
| 90.00 | 150 |
| 90.00 | 200 |
| 95.17 | 250 |
| 103.92 | 300 |
| 104.00 | 312 |
| 190.00 | 313 |
| 190.00 | 350 |
| 190.00 | 400 |
| 190.00 | 450 |
| 190.00 | 500 |
| 190.00 | 550 |
| 190.00 | 600 |
| 190.00 | 650 |
| 195.16 | 700 |
| 200.71 | 750 |
| 205.71 | 800 |
| 210.26 | 850 |
| 214.42 | 900 |
| 218.27 | 950 |
| 221.84 | 1000 |
| 225.16 | 1050 |
| 228.29 | 1100 |
| 231.23 | 1150 |
| 234.01 | 1200 |
| 236.63 | 1250 |
| 239.13 | 1300 |
| 241.51 | 1350 |
| 243.79 | 1400 |
| 245.97 | 1450 |
| 248.05 | 1500 |
| 250.05 | 1550 |
| 251.97 | 1600 |

## Table 17: JAFNPP Curve C Values for 54 EFPY

| | | |
|---|---|---|
| Plant = | Fitzpatrick | |
| Curve A Leak Test Temperature = | 160.0 | °F |
| Curve A Pressure = | 1,025.0 | psig |
| Unit Pressure = | 1,563 | psig (hydrostatic pressure) |
| Flange $RT_{NDT}$ = | 30.0 | °F |

| Adjusted P-T Curve Temperature | Adjusted P-T Curve Pressure |
|---|---|
| 90.00 | 0 |
| 90.00 | 50 |
| 90.00 | 100 |
| 90.00 | 150 |
| 90.00 | 200 |
| 95.17 | 250 |
| 103.92 | 300 |
| 104.00 | 312 |
| 190.00 | 313 |
| 190.00 | 350 |
| 190.00 | 400 |
| 190.00 | 450 |
| 190.00 | 500 |
| 190.00 | 550 |
| 190.00 | 600 |
| 194.02 | 650 |
| 200.26 | 700 |
| 205.82 | 750 |
| 210.81 | 800 |
| 215.35 | 850 |
| 219.52 | 900 |
| 223.36 | 950 |
| 226.93 | 1000 |
| 230.27 | 1050 |
| 233.39 | 1100 |
| 236.33 | 1150 |
| 239.10 | 1200 |
| 241.74 | 1250 |
| 244.24 | 1300 |
| 246.61 | 1350 |
| 248.88 | 1400 |
| 251.06 | 1450 |
| 253.14 | 1500 |
| 255.14 | 1550 |
| 257.10 | 1600 |

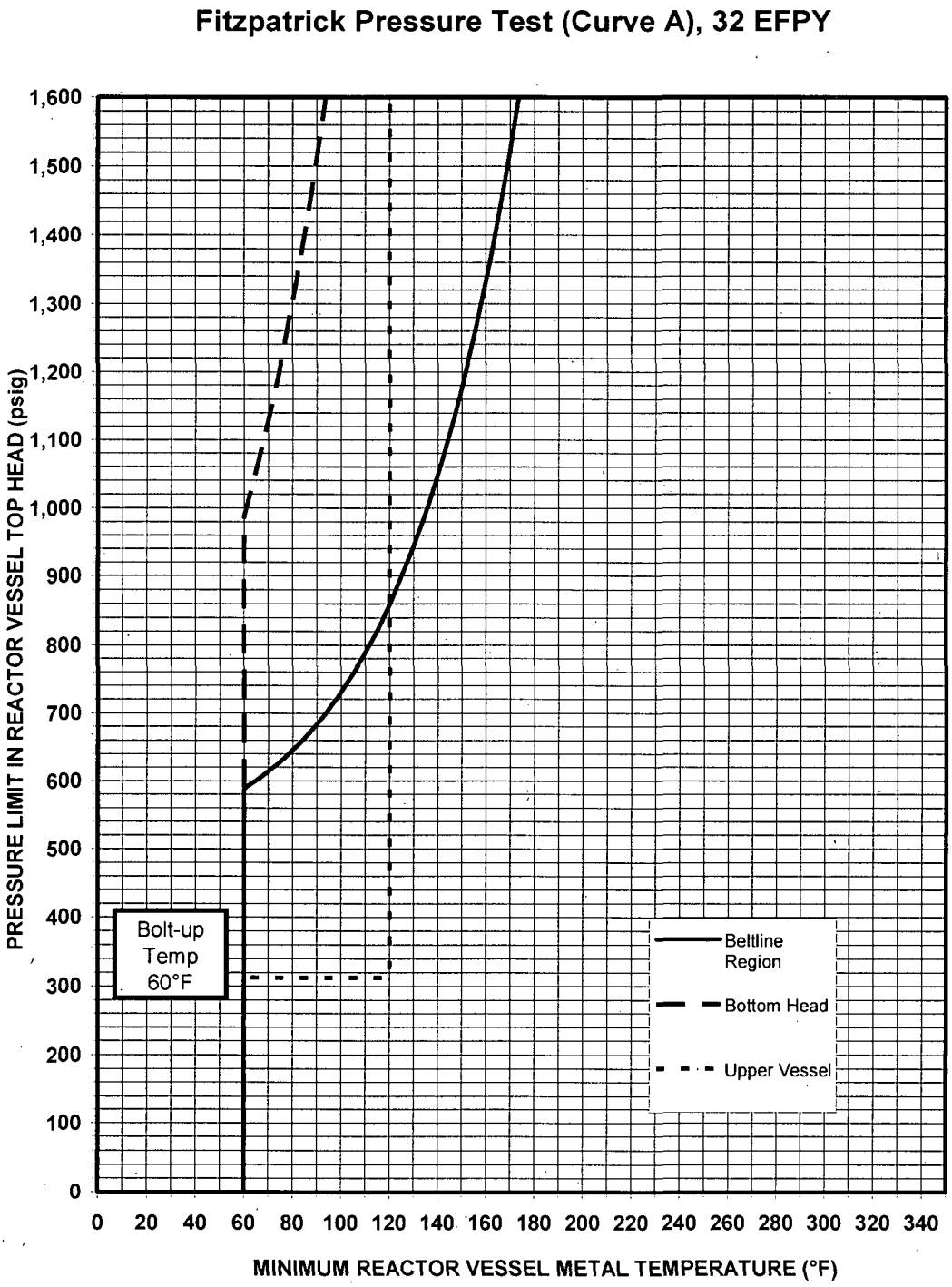



**Figure 1: JAFNPP P-T Curve A (Hydrostatic Pressure and Leak Tests) for 32 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

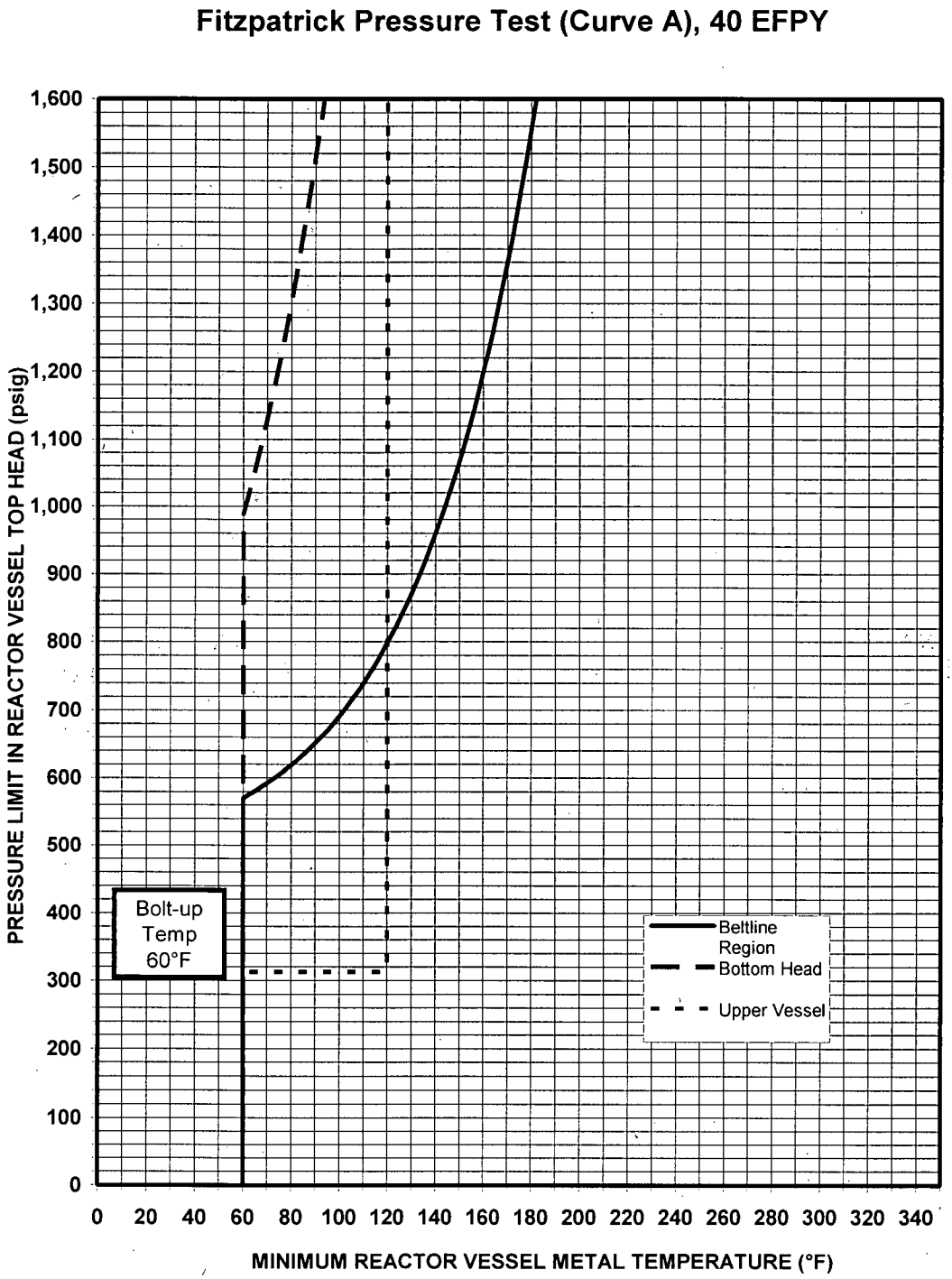



**Figure 2: JAFNPP P-T Curve A (Hydrostatic Pressure and Leak Tests) at 40 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

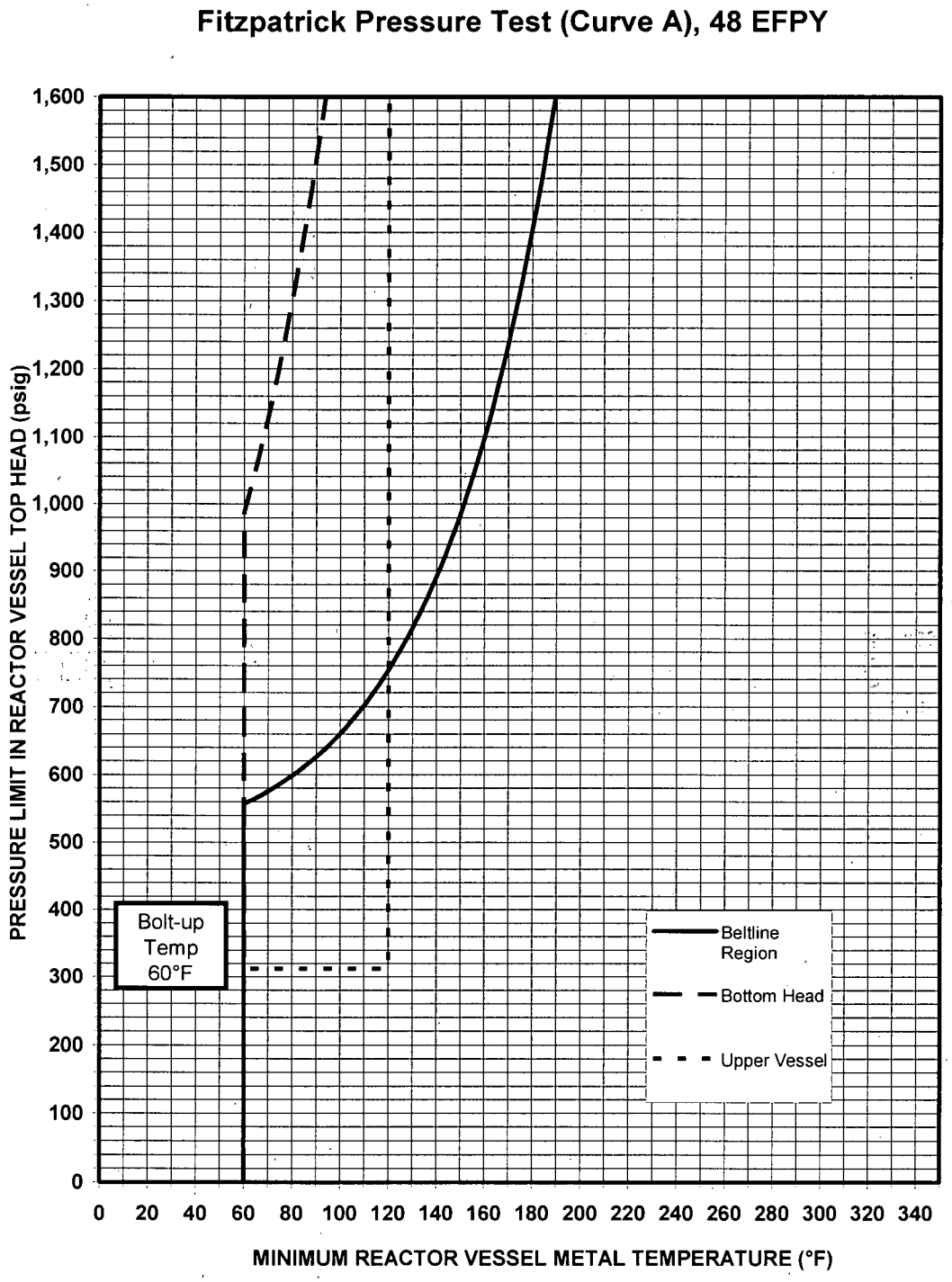



**Figure 3: JAFNPP P-T Curve A (Hydrostatic Pressure and Leak Tests) at 48 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

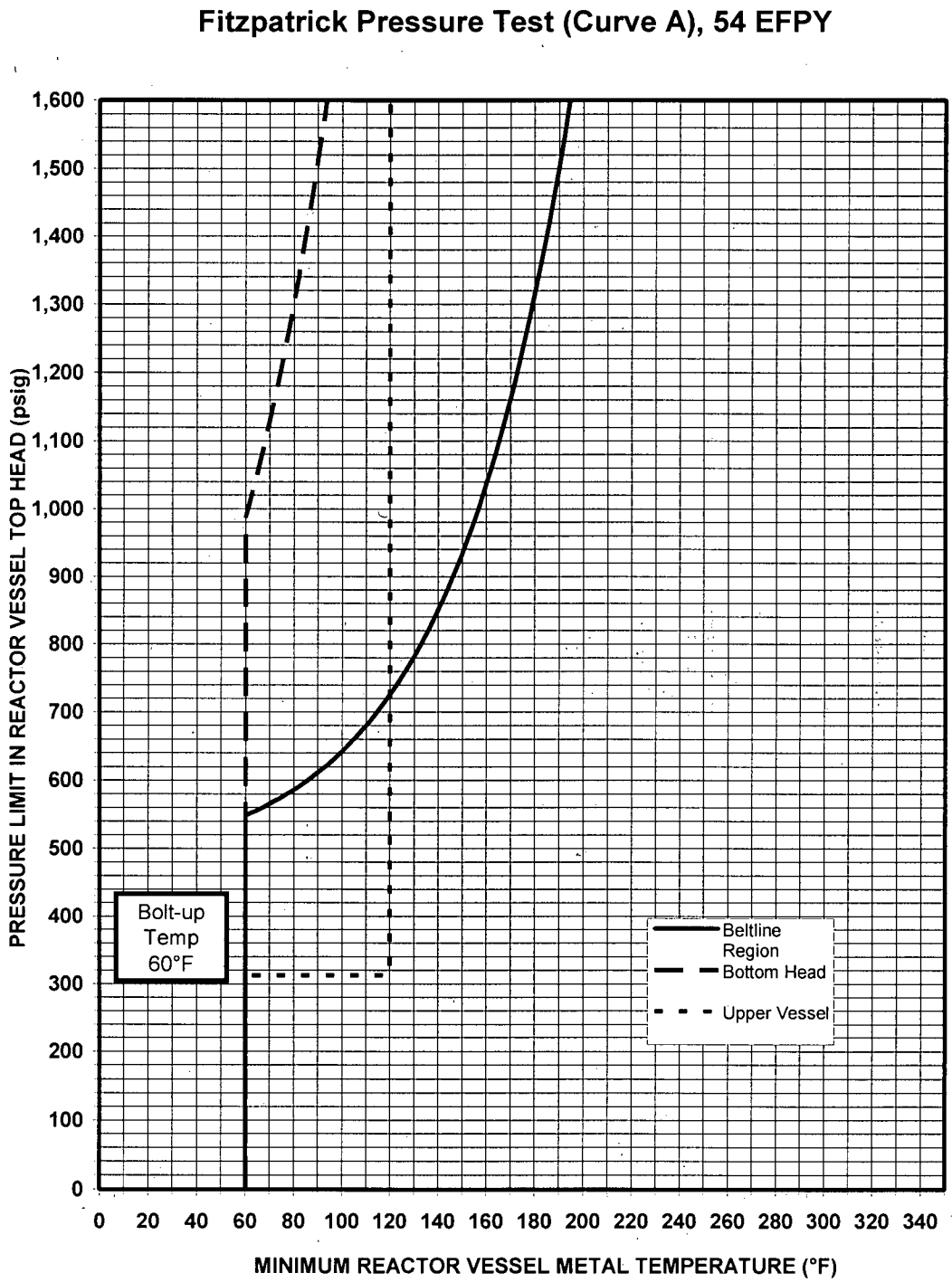



**Figure 4: JAFNPP P-T Curve A (Hydrostatic Pressure and Leak Tests) at 54 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

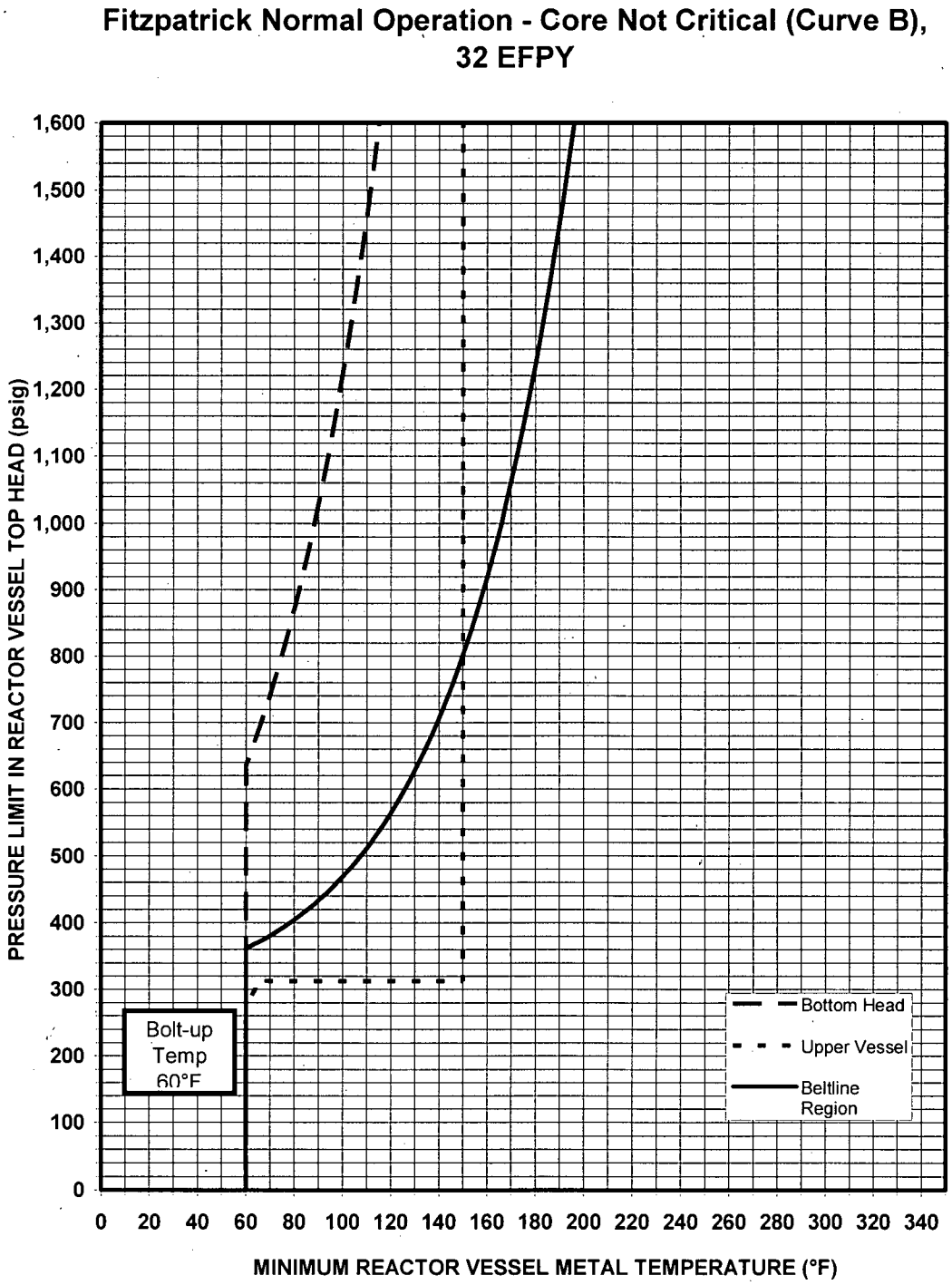



**Figure 5: JAFNPP P-T Curve B (Normal Operation – Core Not Critical) for 32 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

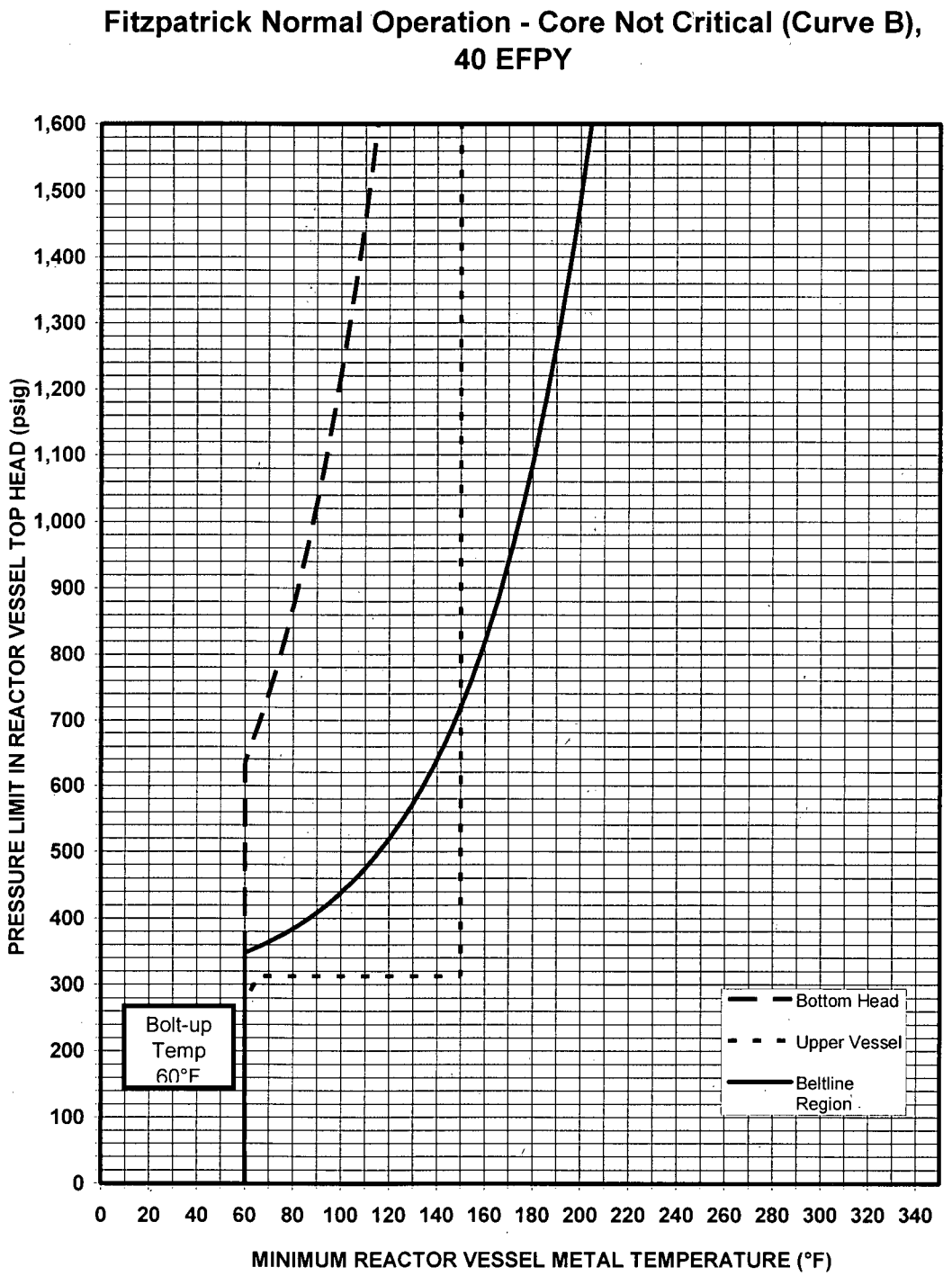



**Figure 6: JAFNPP P-T Curve B (Normal Operation – Core Not Critical) for 40 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

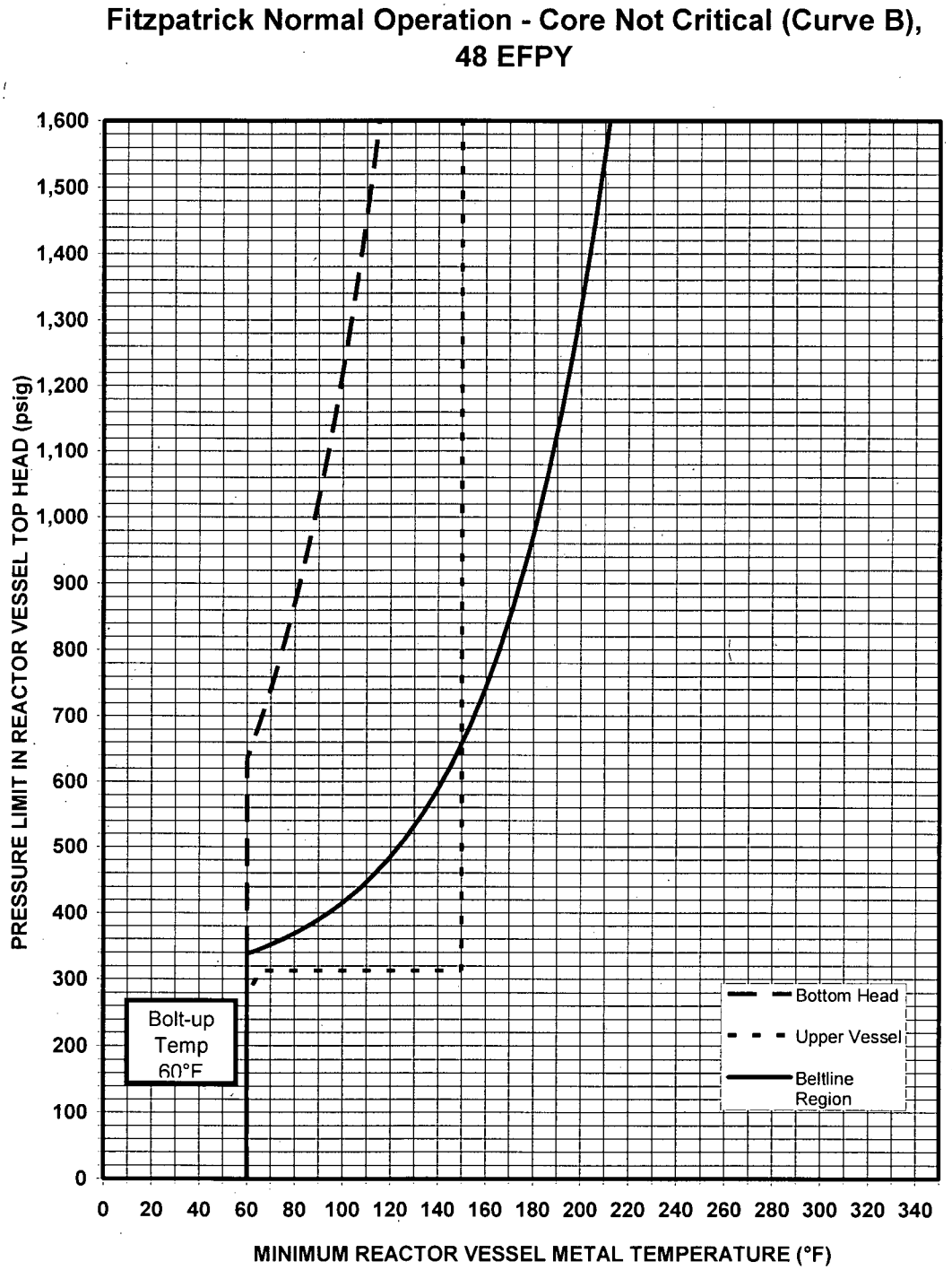



**Figure 7: JAFNPP P-T Curve B (Normal Operation – Core Not Critical) for 48 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

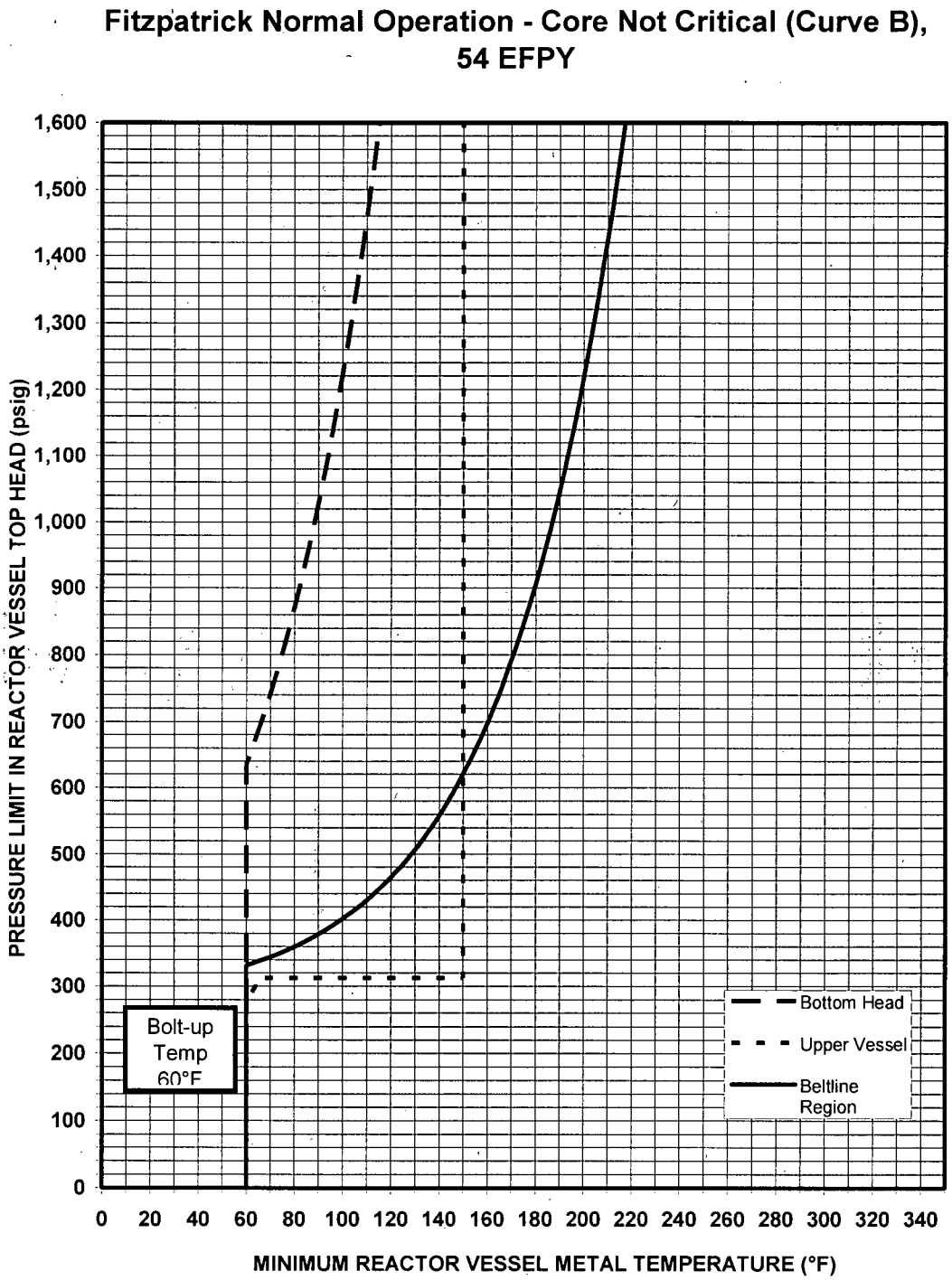



**Figure 8: JAFNPP P-T Curve B (Normal Operation – Core Not Critical) for 54 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

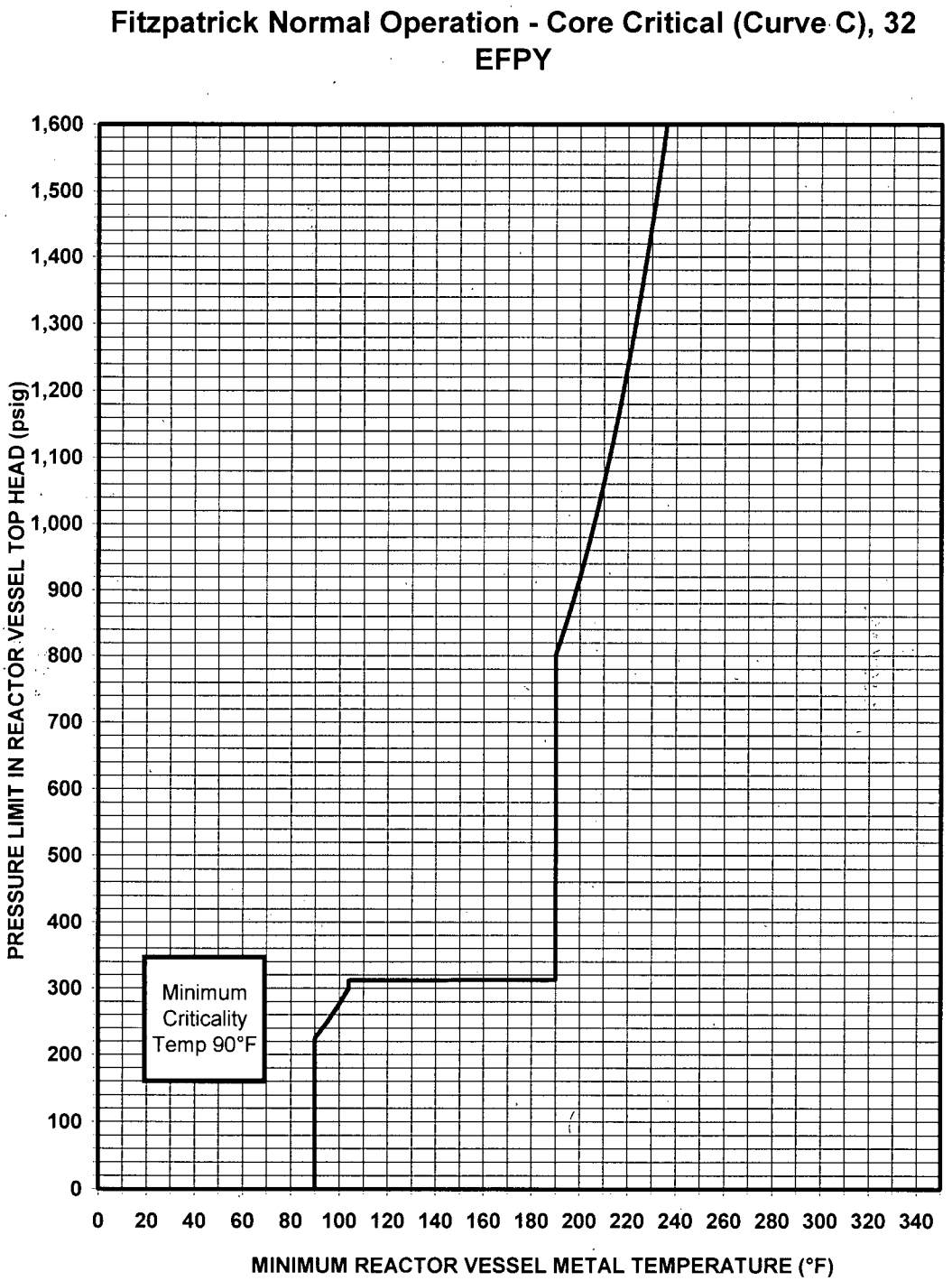



**Figure 9: JAFNPP P-T Curve C (Normal Operation – Core Critical) for 32 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

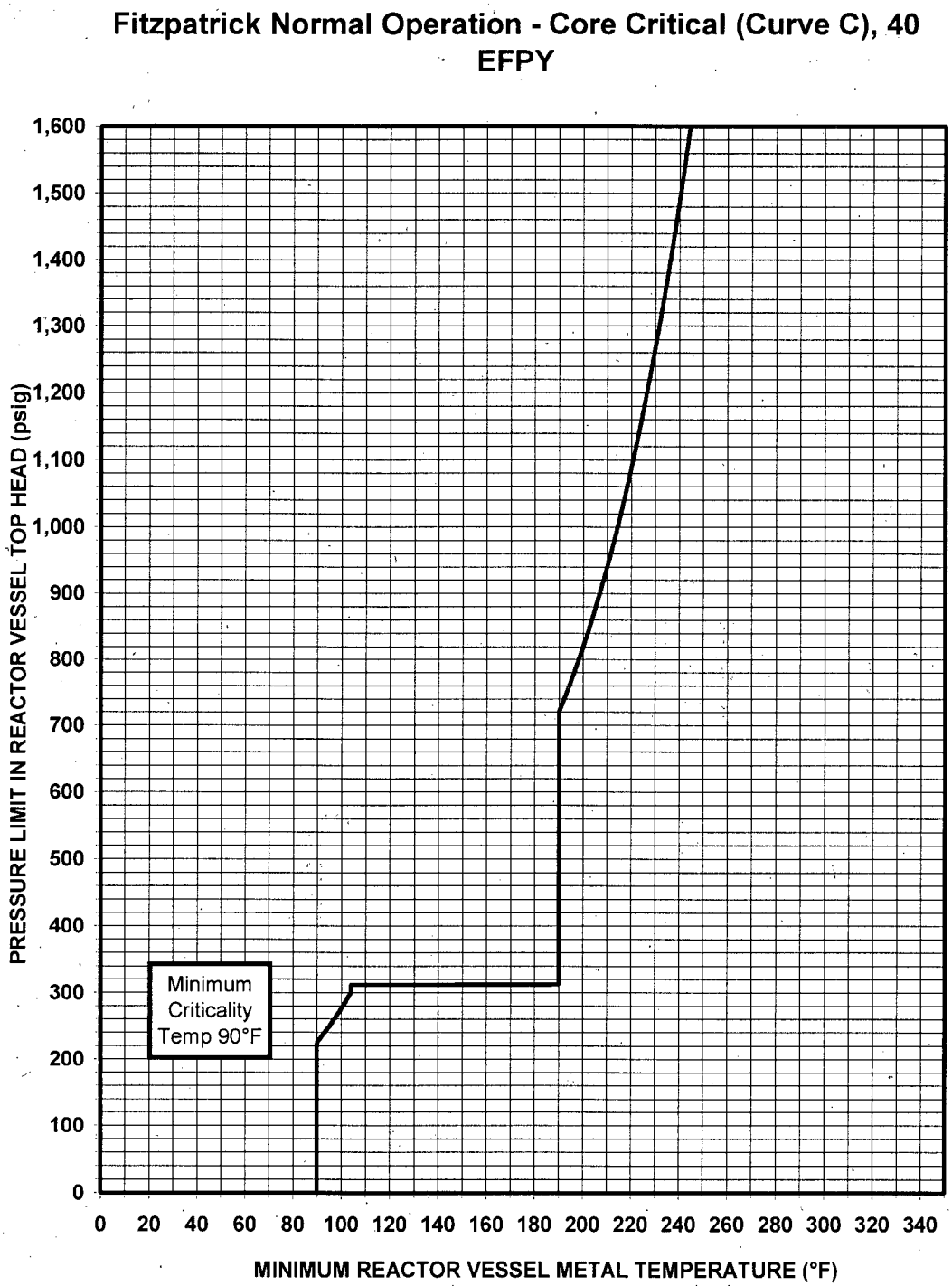



**Figure 10: JAFNPP P-T Curve C (Normal Operation – Core Critical) for 40 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

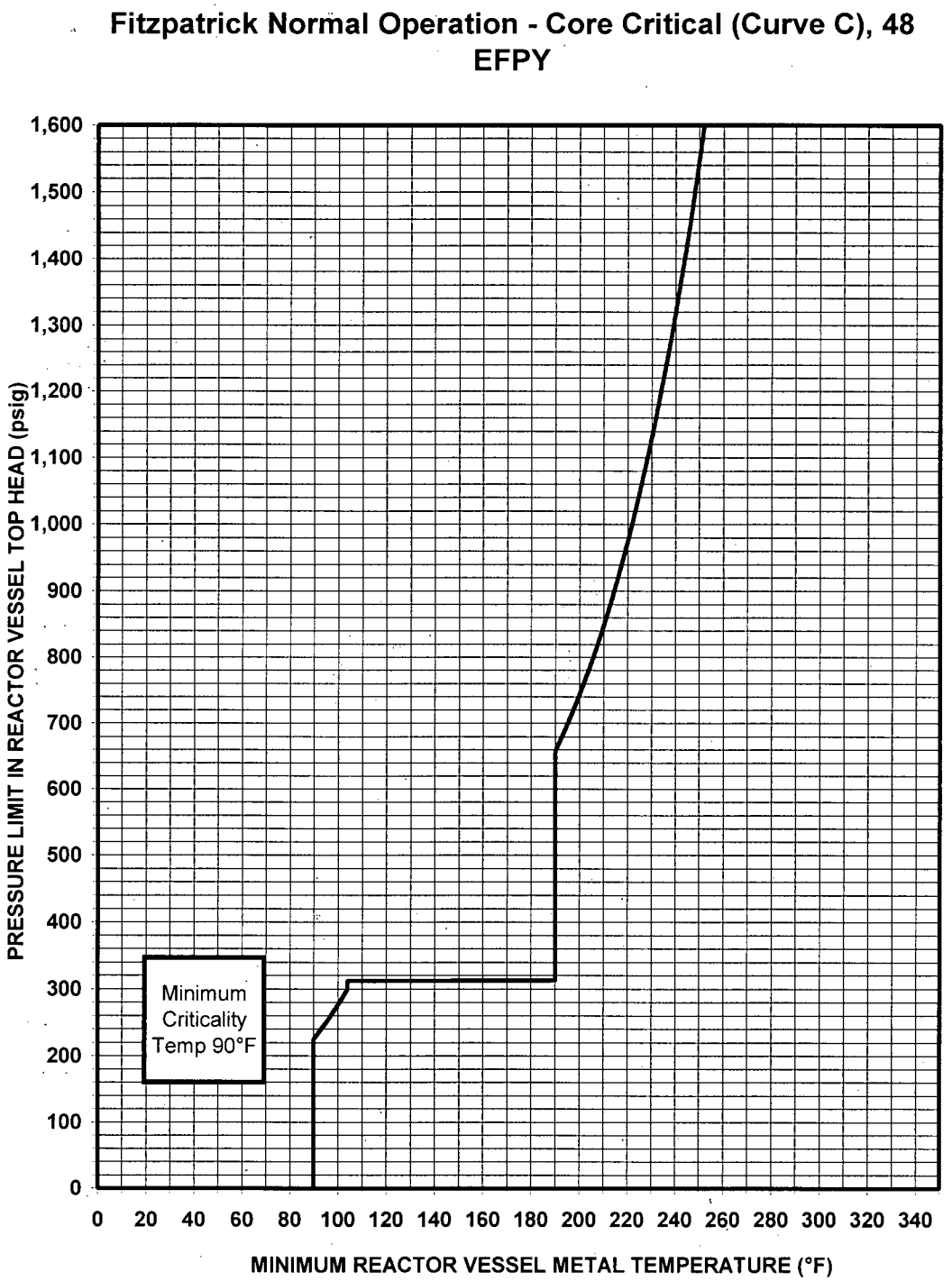



**Figure 11: JAFNPP P-T Curve C (Normal Operation – Core Critical) for 48 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

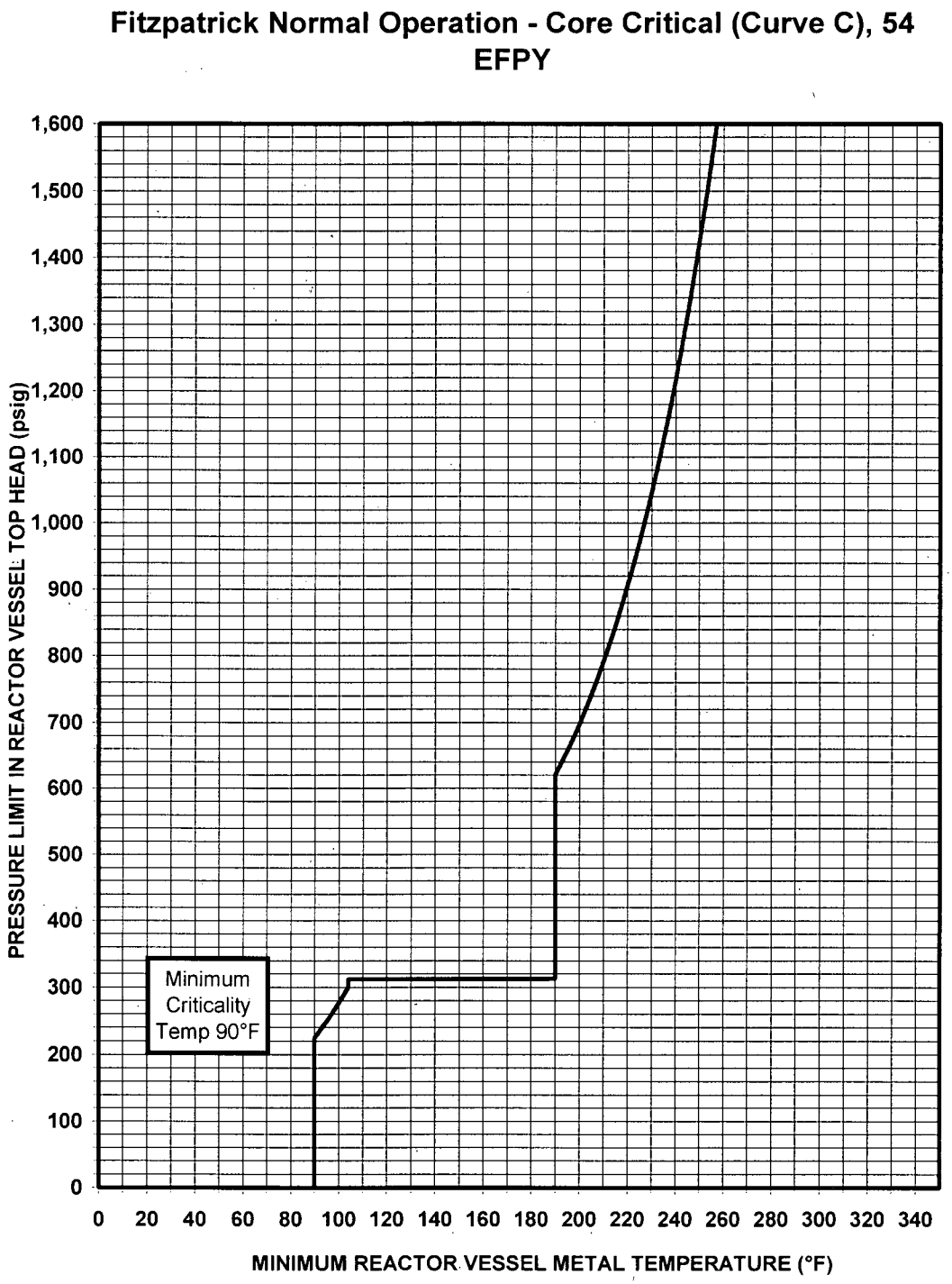



**Figure 12: JAFNPP P-T Curve C (Normal Operation – Core Critical) for 54 EFPY**

*Note: The instrument uncertainty due to temperature and pressure is assumed to be equal to zero, per Section 3.0.*

# APPENDIX A:

# P-T CURVE INPUT LISTING

List of Design Inputs and Source References for JAFNPP P-T Curves at 32 and 40 EFPY

## P-T Curve Inputs

| | | | |
|---|---|---|---|
| **Instrument Uncertainty** | | | **Reference:** |
| | Reactor Vessel Metal Temp | 0 °F | Assumed |
| | Reactor Vessel Pressure | 0 % | Assumed |
| **Geometry** | | | |
| | Vessel Radius | 110.375 in. | CE Report [10] |
| | Vessel Shell thickness | 5.375 in. | CE Report [10] |
| | Bottom Head Thickness | 6.8125 in. | CE Report [10] |
| | Bottom Head Radius | 110.5 in. | CE Report [10] |
| **ART/$RT_{NDT}$** | | | |
| **32 EFPY** | Limiting Beltine | 109.6 °F | SI ART Calc [6] |
| | Limiting Bottom Head | 10 °F | GE Report [7] |
| | Limiting Upper Vessel (Feedwater) $RT_{NDT}$ | 20 °F | GE Report [7] |
| | Flange Material (Boltup) | 30 °F | GE Report [7] |
| **40 EFPY** | Limiting Beltine | 118 °F | SI ART Calc [6] |
| | Limiting Bottom Head | 10 °F | GE Report [7] |
| | Limiting Upper Vessel (Feedwater) $RT_{NDT}$ | 20 °F | GE Report [7] |
| | Flange Material (Boltup) | 30 °F | GE Report [7] |
| **Safety Factor/Stress Concentration Factor** | | | |
| | Core Not Critical (Curve B) Core Critical (Curve C) | 2 | PTLR [5] |
| | Pressure (Curve A) | 1.5 | PTLR [5] |
| | Lower Penetrations (SCF) | 3 | PTLR [5] |
| **$K_{It}$** | | | |
| | During Pressure Test (near isothermal conditions) | 0 | Assumed |
| **Water** | | | |
| | Density | 62.4 lb/ft3 | Assumed |
| | Pressure | 1250 psig | GE Dwg [9] |
| | Water Elevation (pressure head) | 825.2 in | GE Report [7] |
| | Hydrostatic Test Pressure | 1563 psig | Calculated |
| | Static Head Pressure Adjustment | 29.8 psig | Calculated |
| **Assumed Temperature** | | | |
| | Bolt Up Temperature | 60 | PTLR [5] |
| | Increment | 2 | Assumed |
| **Rate of Temp Change** | | | |
| | Heat Up and Cool Down Rate | 100 °F | GE Dwg [9] |

List of Design Inputs and Source References for JAFNPP P-T Curves at 48 and 54 EFPY

## P-T Curve Inputs

| | | | |
|---|---|---|---|
| **Instrument Uncertainty** | | | **Reference:** |
| | Reactor Vessel Metal Temp | 0 °F | Assumed |
| | Reactor Vessel Pressure | 0 % | Assumed |
| **Geometry** | | | |
| | Vessel Radius | 110.375 in. | CE Report [10] |
| | Vessel Shell thickness | 5.375 in. | CE Report [10] |
| | Bottom Head Thickness | 6.8125 in. | CE Report [10] |
| | Bottom Head Radius | 110.5 in. | CE Report [10] |
| **ART/$RT_{NDT}$** | | | |
| **48 EFPY** | Limiting Beltine | 125.5 °F | SI ART Calc [6] |
| | Limiting Bottom Head | 10 °F | GE Report [7] |
| | Limiting Upper Vessel (Feedwater) $RT_{NDT}$ | 20 °F | GE Report [7] |
| | Flange Material (Boltup) | 30 °F | GE Report [7] |
| **54 EFPY** | Limiting Beltine | 130.6 °F | SI ART Calc [6] |
| | Limiting Bottom Head | 10 °F | GE Report [7] |
| | Limiting Upper Vessel (Feedwater) $RT_{NDT}$ | 20 °F | GE Report [7] |
| | Flange Material (Boltup) | 30 °F | GE Report [7] |
| **Safety Factor/Stress Concentration Factor** | | | |
| | Core Not Critical (Curve B) Core Critical (Curve C) | 2 | PTLR [5] |
| | Pressure (Curve A) | 1.5 | PTLR [5] |
| | Lower Penetrations (SCF) | 3 | PTLR [5] |
| **$K_{It}$** | | | |
| | During Pressure Test (near isothermal conditions) | 0 | Assumed |
| **Water** | | | |
| | Density | 62.4 lb/ft3 | Assumed |
| | Pressure | 1250 psig | GE Dwg [9] |
| | Water Elevation (pressure head) | 825.2 in | GE Report [7] |
| | Hydrostatic Test Pressure | 1563 psig | Calculated |
| | Static Head Pressure Adjustment | 29.8 psig | Calculated |
| **Assumed Temperature** | | | |
| | Bolt Up Temperature | 60 | PTLR [5] |
| | Increment | 2 | Assumed |
| **Rate of Temp Change** | | | |
| | Heat Up and Cool Down Rate | 100 °F | GE Dwg [9] |

# APPENDIX B:

# DEVELOPMENT OF SATURATED STEAM CURVE FITS

## Curve Fit for Saturated Steam

***Reference:*** Steam Table data obtained from "Steam Tables, Properties of Saturated and Superheated Steam," CE Power Systems, 7th Printing.

**Curve Fit:** $T_{sat} = 119.3*(0.7987)^{(1/Psat)} * P_{sat}^{0.2198}$

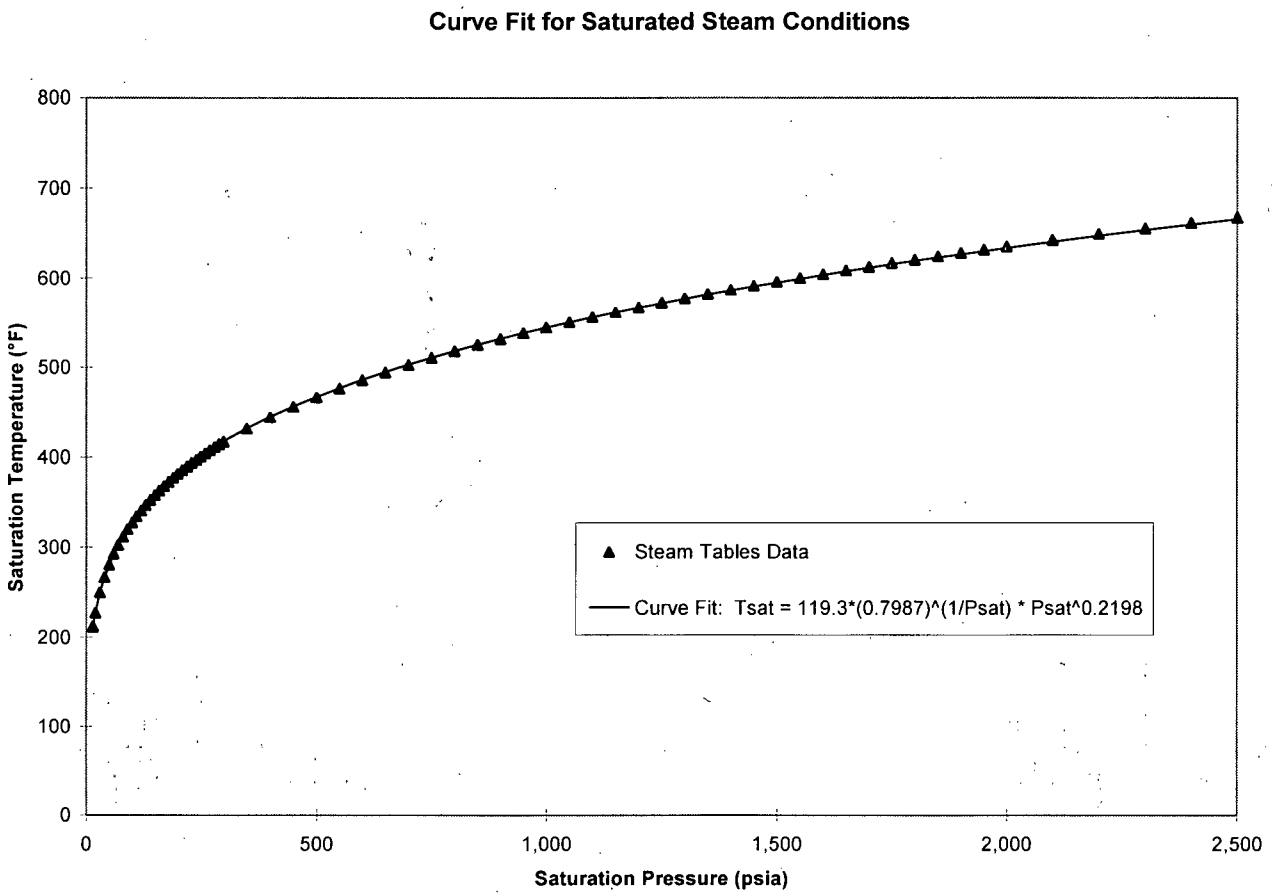
| Pressure $P_{sat}$ (psia) | Temperature $T_{sat}$ (°F) | Curve Fit $T_{sat}$ (°F) | Difference (°F) | Error (%) |
|---|---|---|---|---|
| 14.696 | 212.00 | 212.10 | 0.10 | 0.05% |
| 15 | 213.03 | 213.13 | 0.10 | 0.05% |
| 20 | 227.96 | 227.89 | -0.07 | -0.03% |
| 30 | 250.34 | 250.07 | -0.27 | -0.11% |
| 40 | 267.25 | 266.89 | -0.36 | -0.13% |
| 50 | 281.02 | 280.62 | -0.40 | -0.14% |
| 60 | 292.71 | 292.32 | -0.39 | -0.13% |
| 70 | 302.93 | 302.55 | -0.38 | -0.13% |
| 80 | 312.04 | 311.69 | -0.35 | -0.11% |
| 90 | 320.28 | 319.96 | -0.32 | -0.10% |
| 100 | 327.82 | 327.54 | -0.28 | -0.09% |
| 110 | 334.79 | 334.54 | -0.25 | -0.07% |
| 120 | 341.27 | 341.06 | -0.21 | -0.06% |
| 130 | 347.33 | 347.16 | -0.17 | -0.05% |
| 140 | 353.04 | 352.91 | -0.13 | -0.04% |
| 150 | 358.43 | 358.34 | -0.09 | -0.03% |
| 160 | 363.55 | 363.49 | -0.06 | -0.02% |
| 170 | 368.42 | 368.40 | -0.02 | -0.01% |
| 180 | 373.08 | 373.08 | 0.00 | 0.00% |
| 190 | 377.53 | 377.57 | 0.04 | 0.01% |
| 200 | 381.80 | 381.87 | 0.07 | 0.02% |
| 210 | 385.91 | 386.01 | 0.10 | 0.03% |
| 220 | 389.88 | 390.00 | 0.12 | 0.03% |
| 230 | 393.70 | 393.84 | 0.14 | 0.04% |
| 240 | 397.39 | 397.56 | 0.17 | 0.04% |
| 250 | 400.97 | 401.16 | 0.19 | 0.05% |
| 260 | 404.44 | 404.65 | 0.21 | 0.05% |
| 270 | 407.80 | 408.03 | 0.23 | 0.06% |
| 280 | 411.07 | 411.32 | 0.25 | 0.06% |
| 290 | 414.25 | 414.51 | 0.26 | 0.06% |
| 300 | 417.35 | 417.62 | 0.27 | 0.07% |
| 350 | 431.73 | 432.06 | 0.33 | 0.08% |
| 400 | 444.60 | 444.97 | 0.37 | 0.08% |
| 450 | 456.28 | 456.67 | 0.39 | 0.08% |
| 500 | 467.01 | 467.39 | 0.38 | 0.08% |
| 550 | 476.94 | 477.30 | 0.36 | 0.08% |
| 600 | 486.20 | 486.54 | 0.34 | 0.07% |
| 650 | 494.89 | 495.19 | 0.30 | 0.06% |
| 700 | 503.08 | 503.33 | 0.25 | 0.05% |
| 750 | 510.84 | 511.03 | 0.19 | 0.04% |
| 800 | 518.21 | 518.34 | 0.13 | 0.03% |
| 850 | 525.24 | 525.31 | 0.07 | 0.01% |
| 900 | 531.95 | 531.95 | 0.00 | 0.00% |
| 950 | 538.39 | 538.32 | -0.07 | -0.01% |
| 1000 | 544.58 | 544.43 | -0.15 | -0.03% |

## Curve Fit for Saturated Steam

***Reference:*** Steam Table data obtained from "Steam Tables, Properties of Saturated and Superheated Steam," CE Power Systems, 7th Printing.

**Curve Fit:** $T_{sat} = 119.3*(0.7987)^{(1/Psat)} * P_{sat}^{0.2198}$

| Pressure $P_{sat}$ (psia) | Temperature $T_{sat}$ (°F) | Curve Fit $T_{sat}$ (°F) | Difference (°F) | Error (%) |
|---|---|---|---|---|
| 1050 | 550.53 | 550.31 | -0.22 | -0.04% |
| 1100 | 556.28 | 555.97 | -0.31 | -0.06% |
| 1150 | 561.82 | 561.43 | -0.39 | -0.07% |
| 1200 | 567.19 | 566.71 | -0.48 | -0.08% |
| 1250 | 572.38 | 571.83 | -0.55 | -0.10% |
| 1300 | 577.42 | 576.78 | -0.64 | -0.11% |
| 1350 | 582.32 | 581.59 | -0.73 | -0.13% |
| 1400 | 587.07 | 586.26 | -0.81 | -0.14% |
| 1450 | 591.70 | 590.80 | -0.90 | -0.15% |
| 1500 | 596.20 | 595.22 | -0.98 | -0.16% |
| 1550 | 600.59 | 599.53 | -1.06 | -0.18% |
| 1600 | 604.87 | 603.73 | -1.14 | -0.19% |
| 1650 | 609.05 | 607.83 | -1.22 | -0.20% |
| 1700 | 613.13 | 611.84 | -1.29 | -0.21% |
| 1750 | 617.12 | 615.75 | -1.37 | -0.22% |
| 1800 | 621.02 | 619.58 | -1.44 | -0.23% |
| 1850 | 624.83 | 623.32 | -1.51 | -0.24% |
| 1900 | 628.56 | 626.99 | -1.57 | -0.25% |
| 1950 | 632.22 | 630.58 | -1.64 | -0.26% |
| 2000 | 635.80 | 634.10 | -1.70 | -0.27% |
| 2100 | 642.76 | 640.94 | -1.82 | -0.28% |
| 2200 | 649.45 | 647.53 | -1.92 | -0.30% |
| 2300 | 655.89 | 653.89 | -2.00 | -0.30% |
| 2400 | 662.11 | 660.04 | -2.07 | -0.31% |
| 2500 | 668.11 | 665.99 | -2.12 | -0.32% |
| | | Maximum = | 0.39 | 0.08% |
| | | Minimum = | -2.12 | -0.32% |
| | | Average = | -0.41 | -0.07% |
| | | Std. Deviation | 0.71 | 0.12% |


Curve Fit for Saturated Steam Conditions
Saturation Temperature (°F)
800
700
600
500
400
300
200
100
0
0
500
1,000
1,500
2,000
2,500
Saturation Pressure (psia)
Steam Tables Data
Curve Fit: Tsat = 119.3*(0.7987)^(1/Psat) * Psat^0.2198