ENCLOSURE 8

MONTICELLO NUCLEAR GENERATING PLANT

LICENSE AMENDMENT REQUEST

REVISE THE TECHNICAL SPECIFICATIONS TO INCLUDE A PRESSURE TEMPERATURE LIMITS REPORT

CALCULATION CA 11-005

REVISED P-T CURVES CALCULATION

(SIA No. 1000847.303)

(59 pages follow)

Xcel Energy	Calculation Signature Sheet

Document Information	
NSPM Calculation (Doc) No: 11-005	Revision: 0
Title: Revised PT Curves	
Facility: ☒ MT ☐ PI	Unit: ☒ 1 ☐ 2
Safety Class: ☒ SR ☐ Aug Q ☐ Non SR	
Special Codes: ☐ Safeguards ☐ Proprietary	
Type: **Calc** Sub-Type:	

NOTE:	Print **and** sign name in signature blocks, as required.

Major Revisions	☐ N/A
EC Number: 17502	☒ Vendor Calc
Vendor Name or Code: Structural Integrity Integrity (SIA)	Vendor Doc No: 1000847.303
Description of Revision: New Calculation Issuance	
The following calculation and attachments have been reviewed and deemed acceptable as a legible QA record	☒
Prepared by: (sign) By Vendor / (print) SIA	Date: 1/11/2011
Reviewed by: (sign) Wynter A. McGruder / (print) Wynter McGruder	Date: 1/24/2011
Type of Review: ☐ Design Verification ☐ Tech Review ☒ Suitability Review	
Method Used (For DV Only): ☐ Review ☐ Alternate Calc ☐ Test	
Approved by: (sign) / (print) Steve Kibler	Date: 2/17/11

Minor Revisions	☐ N/A
EC No:	☐ Vendor Calc:
Minor Rev. No:	
Description of Change:	
Pages Affected:	
The following calculation and attachments have been reviewed and deemed acceptable as a legible QA record	☐
Prepared by: (sign) / (print)	Date:
Reviewed by: (sign) / (print)	Date:
Type of Review: ☐ Design Verification ☐ Tech Review ☐ Suitability Review	
Method Used (For DV Only): ☐ Review ☐ Alternate Calc ☐ Test	
Approved by: (sign) / (print)	Date:

Record Retention: Retain this form with the associated calculation for the life of the plant.

Xcel Energy

Calculation Signature Sheet

NOTE:	This reference table is used for data entry into the PassPort Controlled Documents Module reference tables (C012 Panel). It may also be used as the reference section of the calculation. The input documents, output documents and other references should all be listed here. Add additional lines as needed by using the "TAB" key and filling in the appropriate information in each column.

Reference Documents (PassPort C012 Panel from C020)

#	Controlled* Doc? +	Type	Document Name	Document Number	Doc Rev	Ref Type** INPUT	OUTPUT
1			ASME Boiler and Pressure Vessel Code, Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components, 2004 Edition	Section XI	2004	X	
2			US 10 CFR 50 "Domestic Licensing of Production and Utilization Facilities," Appendix G, "Fracture Toughness Requirements," (60 FR 65474 Dec. 19, 1995; 73 FR 5723, Jan. 31, 2008)	10 CFR 50, Appendix G	N/A	X	
3			Structural Integrity Associates Report No. SIR-05-044-A, Revision 0, "Pressure-Temperature Limits Report Methodology for Boiling Water Reactors," April 2007	N/A	N/A	X	
4	X	CALC	SIA Calculation 1000847.301, "Evaluation of Adjusted Reference Temperatures and Reference Temperature Shifts, Revision 1" 11-003, Revision 0	11-003	0	X	
5			U.S. NRC, Reg Guide 1.99 Rev. 2, "Radiation Embrittlement of Reactor Vessel Materials," May 1988	1.99	2	X	
6			SIA Calculation No. NSP-21Q-303, Revision 1, "Determination of the Initial RTNDT and ART Values for Monticello RPV Materials".	N/A	N/A	X	
7	X	SPEC	GE Design Specification No. 22A6996, Revision 0, "Reactor Vessel System Cycling,"	MPS-843	0	X	
8	X	DRAW	Chicago Bridge & Iron Drawing No. 1 Revision 8 "General Plan, 17'2" I.D x 63'-2" Ins Heads Reactor, " NX-8290-13	NX-8290-13	8	X	
9	X	SPEC	GE Design Specification No. 23A1581, Revision 3, "Reactor VesseL-Recirculation Inlet Nozzle-Safe End,"	MPS-1090	3	X	
10			GE Hitachi Nuclear Energy Report SASR 88-99, "Implementation of Regulatory Guide 1.99, Revision 2 for the Monticello Nuclear Generating Plant," Revision 1, January 1989	88-99	1	X	
11	X	CALC	SIA Calculation 1000847.302, "Finite Element Stress Analysis of Monticello RPV Feedwater Nozzle, Revision 0" 11-004, Revision 0	11-004	0	X	

Record Retention: Retain this form with the associated calculation for the life of the plant.

Xcel Energy

Calculation Signature Sheet

12			SIA Calculation 1000720.301, "Finite Element Stress Analysis of Monticello RPV Recirculation Inlet Nozzle", Revision 0"	N/A	N/A	X	
13			ANSYS Mechanical and PrepPost, Release 11.0 (w/ Service Pack 1), ANSYS, Inc. August 2007	N/A	N/A	X	
14							
15							
16							
17							

* Controlled Doc marked with an "X" means the reference can be entered on the C012 panel in black. Unmarked lines will be yellow. If marked with an "X", also list the Doc Type, e.g., CALC, DRAW, VTM, PROC, etc.

** Mark with an "X" if the calculation provides inputs and/or outputs or both. If not, leave blank. (Corresponds to PassPort "Ref Type" codes: **Inputs / Both** = "ICALC", **Outputs** = "OCALC", **Other / Unknown** = blank)

Other PassPort Data

Associated System (PassPort C011, first three columns) **OR** **Equipment References** (PassPort C025, all five columns):

Facility	Unit	System	Equipment Type	Equipment Number
MT	1	RPV		

Superseded Calculations (PassPort C019):

Facility	Calc Document Number	Title
MT	03-101	Determination of Core Critical and Core Non-Critical Pressure Temperature Curves with End of Life RTNDT Shift

Description Codes - Optional (PassPort C018):

Record Retention: Retain this form with the associated calculation for the life of the plant.

XcelEnergy

Calculation Signature Sheet

Code	Description (optional)	Code	Description (optional)

Notes (Nts) - Optional (PassPort X293 from C020):

Topic Notes	Text
☐ Calc Introduction	☐ Copy directly from the calculation Intro Paragraph **or** ☐ See write-up below
☐ (Specify)	

Record Retention: Retain this form with the associated calculation for the life of the plant.

Xcel Energy

Calculation Signature Sheet

Monticello Specific Information

☒ YES ☐ N/A Topic Code(s) (See MT Form 3805): PLEX, RATE
☐ YES ☒ N/A Structural Code(s) (See MT Form 3805):_______

Does the Calculation:

☐ YES ☒ No Require Fire Protection Review? (Using MT Form 3765, "Fire Protection Program Checklist", determine if a Fire Protection Review is required.) If YES, document the engineering review in the EC. If NO, then attach completed MT Form 3765 to the associated EC.

☐ YES ☒ No Affect piping or supports? (If Yes, Attach MT Form 3544.)

☐ YES ☒ No Affect IST Program Valve or Pump Reference Values, and/or Acceptance Criteria? (If Yes, inform IST Coordinator and provide copy of calculation.)

Record Retention: Retain this form with the associated calculation for the life of the plant.

Structural Integrity Associates, Inc. **CALCULATION PACKAGE**	**File No.: 1000847.303** **Project No.: 1000847** Quality Program: ☒ Nuclear ☐ Commercial

PROJECT NAME:
Monticello P-T Curves Revision According to the PTLR Methodology

CONTRACT NO.:
1005, Release 18

CLIENT:	**PLANT:**
Xcel Energy, Inc.	Monticello Nuclear Generating Plant

CALCULATION TITLE:
Revised P-T Curves Calculation

Document Revision	Affected Pages	Revision Description	Project Manager Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
0	1 - 24 A-1 – A-2 B-1 – B-11	Initial Issue	Eric J. Houston EJH 10/09/10	Vikram Marthandam VM 10/08/10 Steve J. White SJW 10/08/10
1	1 - 29 A-1 - A-4 B-1 - B-21	Add intermediate P-T curve at 36 and 40 EFPY for Curve A	Eric J. Houston EJH 1/11/2011	Nadia Crisan NC 1/7/2011 Mark J. Jaeger MJJ 1/7/2011 Steve J. White SJW 1/7/2011

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

This calculation updates the Monticello Nuclear Generating Plant (MNGP) pressure-temperature (P-T) curves for the beltline, bottom head, and feedwater nozzle / upper vessel regions. The P-T curves are developed using the methodology of the 2004 Edition of ASME Code, Section XI, Appendix G [1], 10CFR50 Appendix G [2], and the Boiling Water Reactor Owner's Group (BWROG) Licensing Topical Report on P-T Curves [3]. A full set of P-T curves are developed for all plant conditions at 54 effective full power years (EFPY). In addition, due to operational challenges presented by the leak test results at 54 EFPY, additional Curve A limits are developed at intermediate levels of 36 and 40 EFPY.

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 [3], thus, all equations and values in this section are obtained from Reference [3] 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 [3], 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:

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

where:

K_{Ic} = the lower bound static fracture toughness (ksi√in).

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√in).
- K_{Ic} = the lower bound static fracture toughness factor calculated in Equation 1 (ksi√in).
- K_{It} = the thermal stress intensity factor (ksi√in) from through wall thermal gradients.
- 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, both non-critical and 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 evaluated region. For the beltline (with the exception of nozzles) 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, per region (in.).

For the feedwater nozzle/upper vessel region and the N2 nozzle, 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:

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

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 $\sigma(x) = C_0 + C_1 \cdot x + C_2 \cdot x^2 + C_3 \cdot x^3$. In this equation, "x" represents the radial distance in inches from the inside surface to any point on the crack front.

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

$$P_{allow} = \frac{K_{Ip} \cdot t}{M_m \cdot R_i} \tag{5}$$

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√in).
t = the RPV wall thickness, per region (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 $2 \leq \sqrt{t} \leq 3.464$
$M_m = 3.21$ for $\sqrt{t} > 3.464$
R_i = the inner radius of the RPV, per region (in.).

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

$$P_{allow} = \frac{2 \cdot K_{Ip} \cdot t}{SCF \cdot M_m \cdot R_i} \tag{6}$$

where:

SCF = conservative stress concentration factor to account for bottom head penetration discontinuities; SCF = 3.0 per Reference [3].
P_{allow}, K_{Ip}, t, M_m and R_i are defined in the footnotes of Equation 5.

For the feedwater nozzle / upper vessel region, and the N2 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:

$$P_{allow} = \frac{K_{Ip} \cdot P_{ref}}{K_{Ip-app}} \tag{7}$$

where:

P_{ref} = RPV internal pressure at which the FEA stress coefficients (Equation 8) are valid (psi).
K_{Ip-app} = the applied pressure stress intensity factor (ksi√in).
P_{allow} and K_{Ip} are defined in the footnotes of Equation 5.

The applied pressure stress intensity factor is determined using a polynomial curve-fit approximation for the through-wall pressure stress distribution from a FEA, similar to the methodology of Equation 4:

$$K_{Ip-app} = \sqrt{\pi a}\left[0.706C_{0p} + \frac{2a}{\pi}\cdot 0.537C_{1p} + \frac{a^2}{2}\cdot 0.448C_{2p} + \frac{4a^3}{3\pi}\cdot 0.393C_{3p}\right] \quad (8)$$

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.).
- $C_{0p}, C_{1p}, C_{2p}, C_{3p}$ = pressure stress polynomial coefficients, obtained from a curve-fit from 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. Calculations proceed in this iterative manner until the allowable reactor Pressure (P_{P-T}) exceeds the maximum possible pressure. The maximum pressure limit is set to 1,300 psig.

Step 6: The following minimum temperature requirements apply to the feedwater nozzle / upper vessel region, and the N2 nozzle, according to Table 1 of 10CFR50, Appendix G [2]:

- 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:

$$T_{P-T} = T + U_T \quad (9)$$

$$P_{P-T} = P_{allow} - P_H - U_P \quad (10)$$

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: $P_H = \rho \cdot \Delta h$.
- ρ = Water density at ambient temperature (lb/in^3).
- Δh = Elevation of full height water level in RPV (in.).
- U_P = The pressure instrument uncertainty (psig).

These additional pressure and temperature limits are not applicable to the 10CFR50 Appendix G [2] limits described in Step 6.

Nozzles in the beltline introduce stress concentration effects and have the potential to be more limiting than the generic beltline P-T curves. Nozzles or discontinuities outside the beltline are considered to be bounded by the upper vessel / feedwater nozzle or bottom head region P-T curves [3]. Beltline nozzles may be bounded by the upper vessel / feedwater nozzle curve if all of the following are met: the feedwater nozzle experiences more severe thermal transients, the feedwater nozzle RT_{NDT} is greater than or equal to the beltline nozzle ART, and the beltline and feedwater nozzle have similar transition geometry (blend radius).

The P-T Curves for hydrostatic leak test (Curve A) and normal operation – core not critical (Curve B) may 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 [2] and the Curve A and Curve B limits. Table 1 of Reference [2] requires that core critical P-T limits be 40°F above any Curve A or Curve B limits at all pressures. 10CFR50 Appendix G [2] also stipulates that, above the 20% pressure transition point, the Curve C temperatures must be either the reference temperature (RT_{NDT}) of the closure flange 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 minus coolant temperature instrument uncertainty. According to Reference [2], the minimum bolt-up temperature is equal to the limiting material RT_{NDT} of the regions affected by bolt-up stresses. Consistent with Reference [3], 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 [2] 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 ASSUMPTIONS / DESIGN INPUTS

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

ART values in the MNGP beltline region are obtained for 36, 40, and 54 EFPY from Reference [4]. Note: the height of the beltline increases in direct proportion with EFPY; this change in the beltline region from initial startup to end of life is referred to as the extended beltline. The calculations were performed in accordance with Nuclear Regulatory Commission (NRC) Regulatory Guide 1.99, Revision 2 (RG1.99) [5]. Based on Tables 1, 2, and 3 of Reference [4], the limiting beltline material is the Lower/Intermediate shell plate, which has an ART value of 147.4°F for 36 EFPY, 156.0°F for 40 EFPY, and 186.6°F for 54 EFPY.

Non-beltline regions are not subjected to the effects of fluence; therefore, reference temperature (RT_{NDT}) values are valid substitutions for corresponding ART values. RT_{NDT} values for non-beltline regions are obtained from Reference [6].

The inner radius of the RPV at the feedwater (FW) nozzle, per Figure 3 of Reference [7], is 103.0 inches. The vessel shell thickness is taken as 5.63 inches at the FW nozzle from the same source. Dimensions for the bottom head radius and thickness are obtained from Reference [8], as 103.2 inches and 5.94 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 0°F and 0 psig respectively.

The total height of the RPV is 758 inches, as shown in Reference [8]. The density of the water is assumed to be 64.2 lbm/ft^3. Thus, the static pressure adjustment due to the pressure head of the water in the RPV is conservatively calculated as 27.4 psi for all evaluation regions. The maximum cool-down rate of the vessel is 100°F/hr per Reference [10].

According to Section 2.8 of Reference [3], the minimum bolt-up temperature for the RPV shall be no lower than 60°F. Since the RT_{NDT} values for all regions highly stressed by bolt preload 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 minus coolant temperature uncertainty (0°F in this case). 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 previously applied. 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 [2]. When the Licensing Topical Report (LTR) [3] was developed, SI consciously recognized the additional 60°F margin and chose to exclude it, as it is not technically required.

Vessel nozzles are incorporated into P-T curve calculations using stress distributions from two FEAs [11, 12] and applying them to geometry specific fracture mechanics models. Both the feedwater (upper vessel region) and N2 (recirculation inlet in the extended beltline region) nozzles require this type of analysis, due to bounding transients they experience and/or limiting ART (RT_{NDT} outside beltline) values.

The feedwater nozzle is the bounding component in the upper vessel because it is a stress concentrator (essentially a hole in a plate) and because it typically experiences more severe thermal transients compared to the rest of the upper vessel region. A one-quarter, 3-dimensional finite element model (FEM) of the feedwater nozzle is created in Reference [11] using the ANSYS finite element software [13]. Both pressure and thermal hoop stress distributions are obtained along a limiting path in the nozzle-to-RPV blend radius. The pressure stress analysis is run for an applied unit pressure of 1,000 psig [11]. Post-processing techniques are used to extract the stresses acting normal to the postulated 1/4t crack (hoop stresses), along the limiting path in Reference [11]. Two thermal transients are also run in Reference [11], and the hoop stresses are extracted along the limiting path at each time step. A 3rd order polynomial curve fit of the hoop stresses will be performed. The applied stress intensity factor due to pressure will be calculated using Equation 8. The thermal stress intensity factor will be calculated for all time steps using Equation 4, with the bounding, or most limiting value, being applied for all temperatures. The limiting path defines the nozzle corner thickness to be 7.73 inches [11] and the postulated flaw location at 1/4t to be 1.93 inches.

MNGP has one set of nozzles in the RPV beltline where the fluence exceeds 1.0×10^{17} n/cm^2. These nozzles introduce stress concentration effects to the beltline plates and must be specifically analyzed. The recirculation inlet (N2) nozzles are the only nozzles in the beltline region; there are no instrument nozzles in the extended beltline [4]. The N2 nozzle limiting ART values for 36, 40 and 54 EFPY are 104.1°F, 110.0°F, and 125.2°F, respectively, per Reference [4]. Similar to the feedwater nozzle, the thermal and pressure stress distributions for the N2 nozzle are extracted from a FEM in Reference [12] along a limiting path in the nozzle-to-RPV blend radius. The distributions are fit with a 3rd order polynomial in Reference [12]. The applied stress intensity factor due to the unit pressure of 1,000 psig will be calculated using Equation 8. The thermal stress intensity factor will be calculated for all time steps using Equation 4, with the bounding value being applied for all temperatures. The limiting path defines the nozzle corner thickness to be 9.29 inches [12] and the postulated flaw location at 1/4t to be 2.32 inches.

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.

The polynomial stress coefficients in Table 1 are applied to Equations 4 and 8. For the feedwater nozzle, the resulting applied pressure stress intensity (K_{Ip-app}) and thermal stress intensity (K_{It}) factors are 69.11 ksi$\sqrt{in}$ and 7.06 ksi$\sqrt{in}$, respectively. The resulting applied pressure stress intensity (K_{Ip-app}) and thermal stress intensity (K_{It}) factors are 74.36 ksi$\sqrt{in}$ and 9.45 ksi$\sqrt{in}$ for the N2 nozzle (Table 2).

In order to incorporate the limiting recirculation inlet (N2) nozzle curves into the beltline, a composite curve is developed which bounds each of the two curves (Beltline and N2 nozzle). This composite curve is used to describe the pressure and temperature limits for the beltline region. Supporting beltline calculations for pressure test (Curve A) and Normal Operation – Core Not Critical (Curve B) are shown in Appendix B.

The P-T limits for Curve A at 54 EFPY present operability challenges for MNGP, primarily due to the limiting ART value for the beltline region. Reference [4] includes calculations for intermediate ART values at 36 and 40 EFPY. Consequently, P-T limits for Curve A will be developed at 36, 40 and 54 EFPY. The intermediate evaluation will not be performed for Curve B and Curve C, as the 54 EFPY limits for these curves do not present an operational challenge to MNGP.

4.1 Pressure Test (Curve A)

The minimum bolt-up temperature of 60°F minus instrument uncertainty (0°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 factor (K_{Ip}). The allowable RPV pressure is calculated for the beltline, bottom head and upper vessel regions using Equations 5, 6, and 7, as appropriate. 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 9 and 10, respectively.

The data resulting from each P-T curve calculation is tabulated. Values for the beltline region at 36, 40 and 54 EFPY are provided in Table 3, Table 4 and 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 is graphed, and the resulting P-T curves for 36, 40 and 54 EFPY are provided in Figure 1, Figure 2, and Figure 3, respectively.

4.2 Normal Operation – Core Not Critical (Curve B)

The minimum bolt-up temperature of 60°F minus coolant temperature instrument uncertainty (0°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 plate and bottom head regions using Equation 3, and for the feedwater and N2 nozzle using Equation 4.

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 factor (K_{Ip}). The allowable RPV pressure is calculated for the beltline, bottom head, and upper vessel regions using Equations 5, 6, and 7, as appropriate. 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 9 and 10, respectively.

The data resulting from each P-T curve calculation is tabulated. Values for the beltline region at 54 EFPY are given in Table 8. Data for the bottom head region is listed in Table 9, data for the feedwater nozzle / upper vessel region is presented in Table 10. The data for each region is graphed, and the resulting P-T curves for 54 EFPY are provided in Figure 4.

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} that is highly stressed by the bolt preload (in this case, that of the closure flange region: 10°F per Section 3.0) plus 60°F, resulting in a minimum critical temperature of 70°F. When the pressure exceeds 20% of the pre-service system hydro-test pressure (20% of 1,563 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 (3) regions of Curve B P-T curves.

Tabulated overall values of Curve C are provided at 54 EFPY in Table 11. The corresponding P-T curve plot is given in Figure 5.

5.0 CONCLUSIONS

P-T curves are developed for MNGP 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 are developed at 54 EFPY, including the following plant conditions: Pressure Test (Curve A), Normal Operation – Core Not Critical (Curve B), and Normal Operation – Core Critical (Curve C). Calculations are performed for the beltline, bottom head, feedwater nozzle / upper vessel regions and the recirculation inlet (N2) nozzles. In addition, due to operational challenges presented by the leak test results at 54 EFPY, additional Curve A limits are developed at intermediate levels of 36 and 40 EFPY.

Tabulated pressure and temperature values are provided for all regions and EFPY levels in Table 3 through Table 11. The accompanying P-T curve plots are provided in Figure 1 through Figure 5.

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, 2004 Edition.
2. U.S. Code of Federal Regulations, Title 10, Energy, Part 50, "Domestic Licensing of Production and Utilization Facilities," Appendix G, "Fracture Toughness Requirements," (60 FR 65474, Dec. 19, 1995; 73 FR 5723, Jan. 31, 2008).
3. Structural Integrity Associates Report No. SIR-05-044-A, Revision 0, "Pressure-Temperature Limits Report Methodology for Boiling Water Reactors," April 2007, SI File No. GE-10Q-401.
4. Structural Integrity Associates Calculation No. 1000847.301, Revision 1, "Evaluation of Adjusted Reference Temperatures and Reference Temperature Shifts."
5. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," May 1988.
6. Structural Integrity Associates Calculation No. NSP-21Q-303, Revision 1, "Determination of the Initial RT_{NDT} and ART Values for the Monticello RPV Materials."
7. GE Design Specification No. 22A6996, Revision 0, "Reactor Vessel System Cycling," SI File No. 1000847.201.
8. CB&I Drawing No. 1, Revision 8, "General Plan. 17'2" ID x 63' 2" Ins Heads Nuclear Reactor," NX-8290-13, SI File No. NSP-21Q-210.
9. GE Design Specification No. 23A1581, Revision 3, "Reactor Vessel – Recirculation Inlet Safe End," SI File No. 1000720.202.
10. GE Report No. SASR 88-99, Revision 1, "Implementation of Regulatory Guide 1.99, Revision 2 for the Monticello Nuclear Generating Plant," January 1989, SI File No. NSP-21Q-202
11. Structural Integrity Associates Calculation No. 1000847.302, Revision 0, "Finite Element Stress Analysis of Monticello RPV Feedwater Nozzle."
12. Structural Integrity Associates Calculation No. 1000720.301, Revision 0, "Finite Element Stress Analysis of Monticello RPV Recirculation Inlet Nozzle."
13. ANSYS Mechanical and PrepPost, Release 11.0 (w/ Service Pack 1), ANSYS, Inc., August 2007.

Table 1: MNGP Polynomial Coefficients for Feedwater Nozzle Stress Intensity Distributions

Feedwater Nozzle Pressure Stress Coefficients					K_{Ip-app}
c0	c1	c2	c3		(psi√in)
49728.16	-12761.77	1797.96	-113.63		69,105
Feedwater Nozzle Thermal Stress Coefficients					**K_{It}**
c0	**c1**	**c2**	**c3**		**(psi√in)**
5737.85	-1934.05	106.77	3.72		7,064

Table 2: MNGP Polynomial Coefficients for Recirculation Inlet (N2) Nozzle Stress Intensity Distributions

Recirculation Inlet (N2) Pressure Stress Coefficients					K_{Ip-app}
c0	c1	c2	c3		(psi√in)
49213.40	-10902.90	1312.80	-69.60		74,356
Recirculation Inlet (N2) Thermal Stress Coefficients					**K_{It}**
c0	**c1**	**c2**	**c3**		**(psi√in)**
3727.90	2331.90	-930.10	67.40		9,454

Table 3: MNGP Beltline Region, Curve A, for 36 EFPY

P-T Curve Temperature	P-T Curve Pressure
60.00	0
60.00	50
60.00	100
60.00	150
60.00	200
60.00	250
60.00	300
60.00	312
60.00	313
61.75	350
86.10	400
102.40	450
114.67	500
124.52	550
132.74	600
139.81	650
146.00	700
151.49	750
156.45	800
160.96	850
165.09	900
168.91	950
172.47	1000
175.78	1050
178.88	1100
181.82	1150
184.58	1200
187.19	1250
189.69	1300

Table 4: MNGP Beltline Region, Curve A, for 40 EFPY

P-T Curve Temperature	P-T Curve Pressure
60.00	0
60.00	50
60.00	100
60.00	150
60.00	200
60.00	250
60.00	300
60.00	312
60.00	313
67.65	350
92.00	400
108.30	450
120.57	500
130.42	550
138.64	600
145.71	650
151.89	700
157.39	750
162.35	800
166.86	850
170.99	900
174.81	950
178.37	1000
181.68	1050
184.78	1100
187.71	1150
190.48	1200
193.41	1250
196.73	1300

Table 5: MNGP Beltline Region, Curve A, for 54 EFPY

P-T Curve Temperature	P-T Curve Pressure
60.00	0
60.00	50
60.00	100
60.00	150
60.00	200
60.00	250
60.00	300
60.00	312
60.00	313
82.85	350
107.19	400
123.50	450
135.78	500
145.62	550
153.85	600
160.90	650
167.09	700
172.59	750
177.55	800
184.05	850
191.16	900
197.39	950
202.93	1000
207.92	1050
212.45	1100
216.61	1150
220.44	1200
224.02	1250
227.33	1300

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

Plant =	MNGP	
Component =	Bottom Head	(penetrations portion)
Bottom Head thickness, t =	5.938	inches
Bottom Head Radius, R =	103.1875	inches
ART =	26.0	°F ======> **All EFPY**
K_{It} =	0.00	(no thermal effects)
Safety Factor =	1.50	
Stress Concentration Factor =	3.00	(bottom head penetrations)
M_m =	2.256	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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	74.13	49.42	60	0
60.0	74.13	49.42	60	813
62.0	75.80	50.53	62	832
64.0	77.54	51.69	64	851
66.0	79.34	52.90	66	872
68.0	81.23	54.15	68	893
70.0	83.19	55.46	70	915
72.0	85.23	56.82	72	939
74.0	87.35	58.23	74	963
76.0	89.56	59.71	76	988
78.0	91.86	61.24	78	1,014
80.0	94.25	62.84	80	1,041
82.0	96.75	64.50	82	1,069
84.0	99.34	66.23	84	1,099
86.0	102.04	68.03	86	1,129
88.0	104.85	69.90	88	1,161
90.0	107.77	71.85	90	1,194
92.0	110.82	73.88	92	1,229
94.0	113.98	75.99	94	1,265
96.0	117.28	78.19	96	1,302

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

Plant =	MNGP	
Component =	Upper Vessel	
ART =	40.0	°F ======> All EFPY
Vessel Radius, R =	103	inches
Nozzle corner thickness, t' =	7.732	inches, approximate
K_{It} =	0.00	(no thermal effects)
$K_{Ip\text{-}applied}$ =	69.10	ksi*inch$^{1/2}$
Crack Depth, a =	1.933	inches
Safety Factor =	1.50	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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 coefficients are valid)
Unit Pressure =	1,563	psig (hydrostatic pressure)
Flange RT_{NDT} =	10.0	°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 10CFR50 Adjustments (psig)
60.0	64.13	42.75	60	0
60.0	64.13	42.75	60	313
62.0	65.39	43.60	100	313
64.0	66.71	44.47	100	616
66.0	68.08	45.38	100	629
68.0	69.50	46.33	100	643
70.0	70.98	47.32	100	657
72.0	72.52	48.35	100	672
74.0	74.13	49.42	100	688
76.0	75.80	50.53	100	704
78.0	77.54	51.69	100	721
80.0	79.34	52.90	100	738
82.0	81.23	54.15	100	756
84.0	83.19	55.46	100	775
86.0	85.23	56.82	100	795
88.0	87.35	58.23	100	815
90.0	89.56	59.71	100	837
92.0	91.86	61.24	100	859
94.0	94.25	62.84	100	882
96.0	96.75	64.50	100	906
98.0	99.34	66.23	100	931
100.0	102.04	68.03	100	957
102.0	104.85	69.90	102	984
104.0	107.77	71.85	104	1012
106.0	110.82	73.88	106	1042
108.0	113.98	75.99	108	1072
110.0	117.28	78.19	110	1104
112.0	120.71	80.47	112	1137
114.0	124.28	82.86	114	1172
116.0	128.00	85.33	116	1207
118.0	131.87	87.91	118	1245
120.0	135.90	90.60	120	1284
122.0	140.09	93.39	122	1324
124.0	144.45	96.30	124	1366

Table 8: MNGP, Beltline Region, Curve B, for 54 EFPY

P-T Curve Temperature	P-T Curve Pressure
60.00	0
60.00	50
60.00	100
60.00	150
89.07	200
116.72	250
134.43	300
137.89	312
138.16	313
147.47	350
157.81	400
166.37	450
174.76	500
185.75	550
194.74	600
202.37	650
208.98	700
214.82	750
220.05	800
224.78	850
229.10	900
233.08	950
236.77	1000
240.21	1050
243.41	1100
246.43	1150
249.28	1200
251.98	1250
254.53	1300

Table 9: MNGP, Bottom Head Region, Curve B, for all EFPY

Plant =	MNGP	
Component =	Bottom Head	(penetrations portion)
Bottom Head thickness, t =	5.938	inches
Bottom Head Radius, R =	103.1875	inches
ART =	26.0	°F ======> All EFPY
K_{It} =	8.19	ksi*inch$^{1/2}$
Safety Factor =	2.00	
Stress Concentration Factor =	3.00	(bottom head penetrations)
M_m =	2.256	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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	74.13	32.97	60	0
60.0	74.13	32.97	60	533
62.0	75.80	33.81	62	547
64.0	77.54	34.67	64	562
66.0	79.34	35.58	66	578
68.0	81.23	36.52	68	594
70.0	83.19	37.50	70	610
72.0	85.23	38.52	72	628
74.0	87.35	39.58	74	646
76.0	89.56	40.69	76	664
78.0	91.86	41.84	78	684
80.0	94.25	43.03	80	704
82.0	96.75	44.28	82	725
84.0	99.34	45.58	84	747
86.0	102.04	46.93	86	770
88.0	104.85	48.33	88	794
90.0	107.77	49.79	90	819
92.0	110.82	51.31	92	845
94.0	113.98	52.90	94	872
96.0	117.28	54.55	96	900
98.0	120.71	56.26	98	929
100.0	124.28	58.05	100	960
102.0	128.00	59.91	102	991
104.0	131.87	61.84	104	1,024
106.0	135.90	63.85	106	1,058
108.0	140.09	65.95	108	1,094
110.0	144.45	68.13	110	1,131
112.0	148.99	70.40	112	1,170
114.0	153.72	72.76	114	1,210
116.0	158.63	75.22	116	1,251
118.0	163.75	77.78	118	1,295
120.0	169.08	80.45	120	1,340

Table 10: MNGP, Upper Vessel Region, Curve B, for all EFPY

Plant =	MNGP	
Component =	Upper Vessel	
ART =	40.0	°F ======> All EFPY
Vessel Radius, R =	103	inches
Nozzle corner thickness, t =	7.732	inches, approximate
K_{It} =	7.06	ksi*inch$^{1/2}$
$K_{Ip\text{-}applied}$ =	69.10	ksi*inch$^{1/2}$
Crack Depth, a =	1.933	inches
Safety Factor =	2.00	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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 coefficients are valid)
Unit Pressure =	1,563	psig (hydrostatic pressure)
Flange RT_{NDT} =	10.0	°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	64.13	28.53	60	0
60.0	64.13	28.53	60	313
62.0	65.39	29.16	130	313
64.0	66.71	29.82	130	404
66.0	68.08	30.51	130	414
68.0	69.50	31.22	130	424
70.0	70.98	31.96	130	435
72.0	72.52	32.73	130	446
74.0	74.13	33.53	130	458
76.0	75.80	34.37	130	470
78.0	77.54	35.24	130	483
80.0	79.34	36.14	130	496
82.0	81.23	37.08	130	509
84.0	83.19	38.06	130	523
86.0	85.23	39.08	130	538
88.0	87.35	40.14	130	554
90.0	89.56	41.25	130	570
92.0	91.86	42.40	130	586
94.0	94.25	43.60	130	603
96.0	96.75	44.84	130	622
98.0	99.34	46.14	130	640
100.0	102.04	47.49	130	660
102.0	104.85	48.89	130	680
104.0	107.77	50.35	130	701
106.0	110.82	51.88	130	723
108.0	113.98	53.46	130	746
110.0	117.28	55.11	130	770
112.0	120.71	56.82	130	795
114.0	124.28	58.61	130	821
116.0	128.00	60.47	130	848
118.0	131.87	62.40	130	876
120.0	135.90	64.42	130	905
122.0	140.09	66.51	130	935
124.0	144.45	68.69	130	967
126.0	148.99	70.96	130	1000
128.0	153.72	73.33	130	1034
130.0	158.63	75.78	130	1069
132.0	163.75	78.34	132	1106
134.0	169.08	81.01	134	1145
136.0	174.63	83.78	136	1185
138.0	180.40	86.67	138	1227
140.0	186.40	89.67	140	1270
142.0	192.66	92.80	142	1315

Table 11: MNGP, Curve C, for 54 EFPY

Plant =	**MNGP**	
Curve A Leak Test Temperature =	**206.0**	°F
Curve A Pressure =	**1,025.0**	psig
Unit Pressure =	**1,563**	psig (hydrostatic pressure)
Flange RT_{NDT} =	**10.0**	°F

P-T Curve Temperature	P-T Curve Pressure
70.00	0
70.00	50
70.00	100
70.00	150
129.07	200
156.72	250
174.43	300
177.89	312
206.00	313
206.00	350
206.00	400
206.37	450
214.76	500
225.75	550
234.74	600
242.37	650
248.98	700
254.82	750
260.05	800
264.78	850
269.10	900
273.08	950
276.77	1000
280.21	1050
283.41	1100
286.43	1150
289.28	1200
291.98	1250
294.53	1300

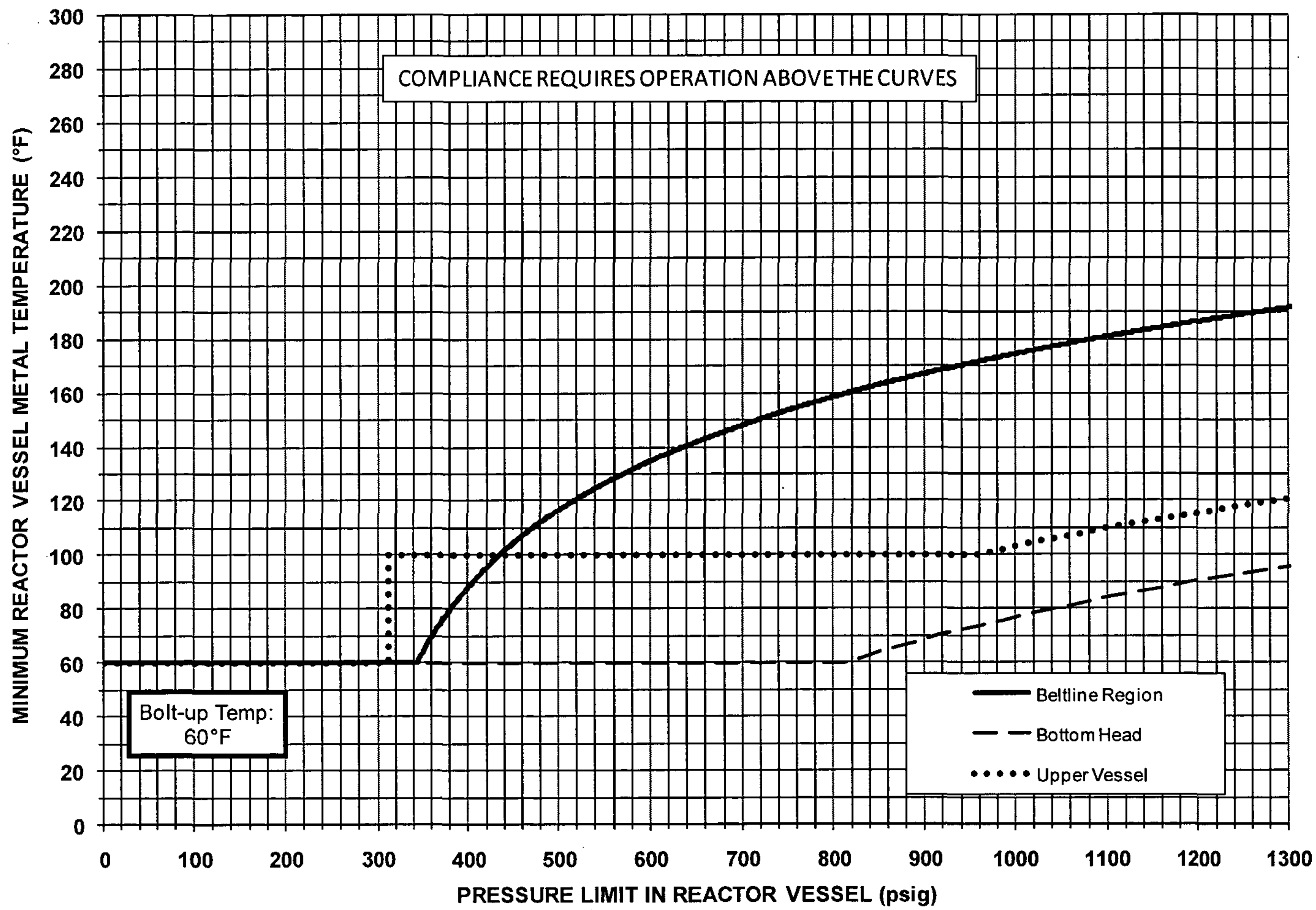


Figure 1. MNGP P-T Curve A (Hydrostatic Pressure and Leak Tests) for 36 EFPY

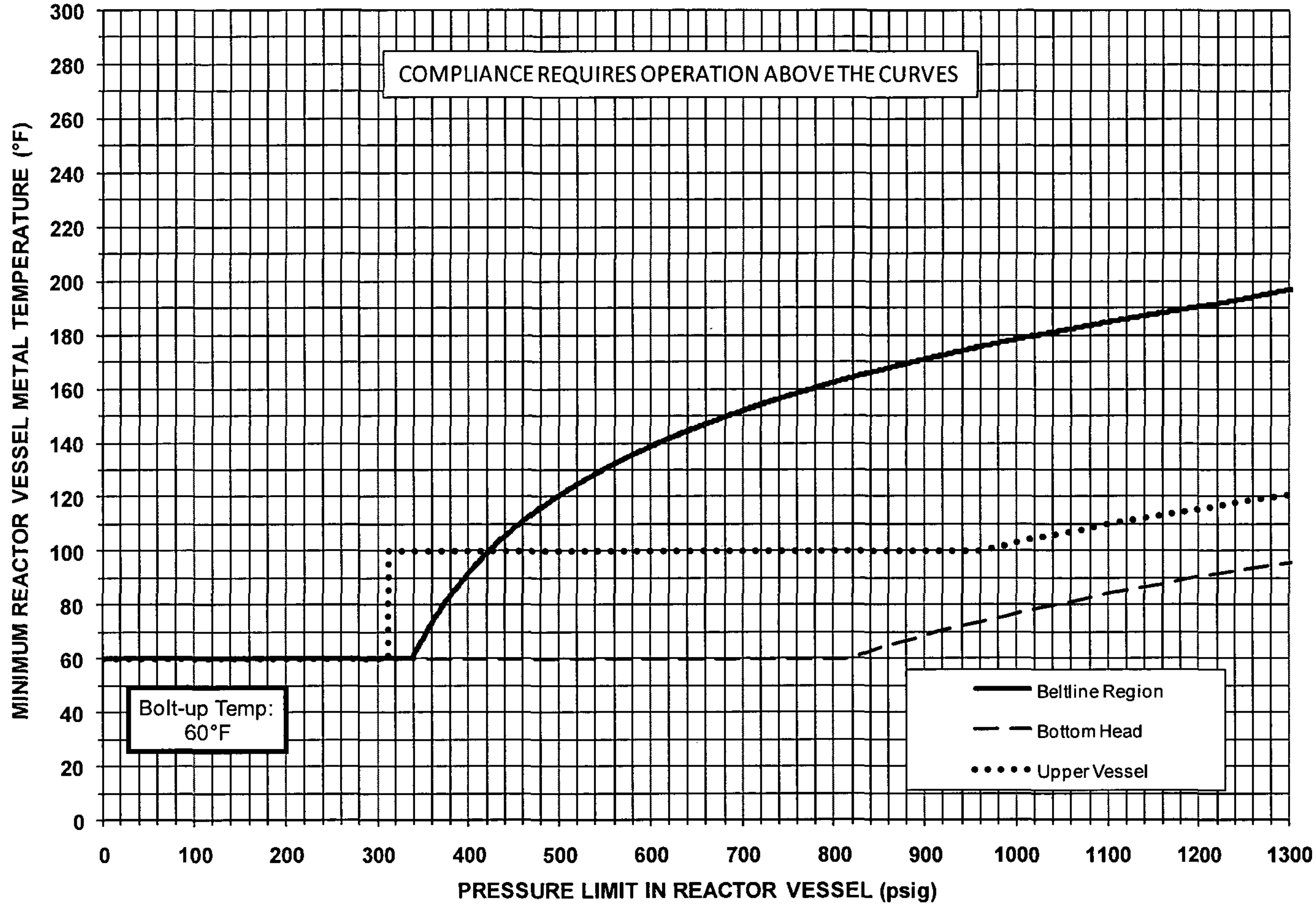


Figure 2: MNGP P-T Curve A (Hydrostatic Pressure and Leak Tests) for 40 EFPY

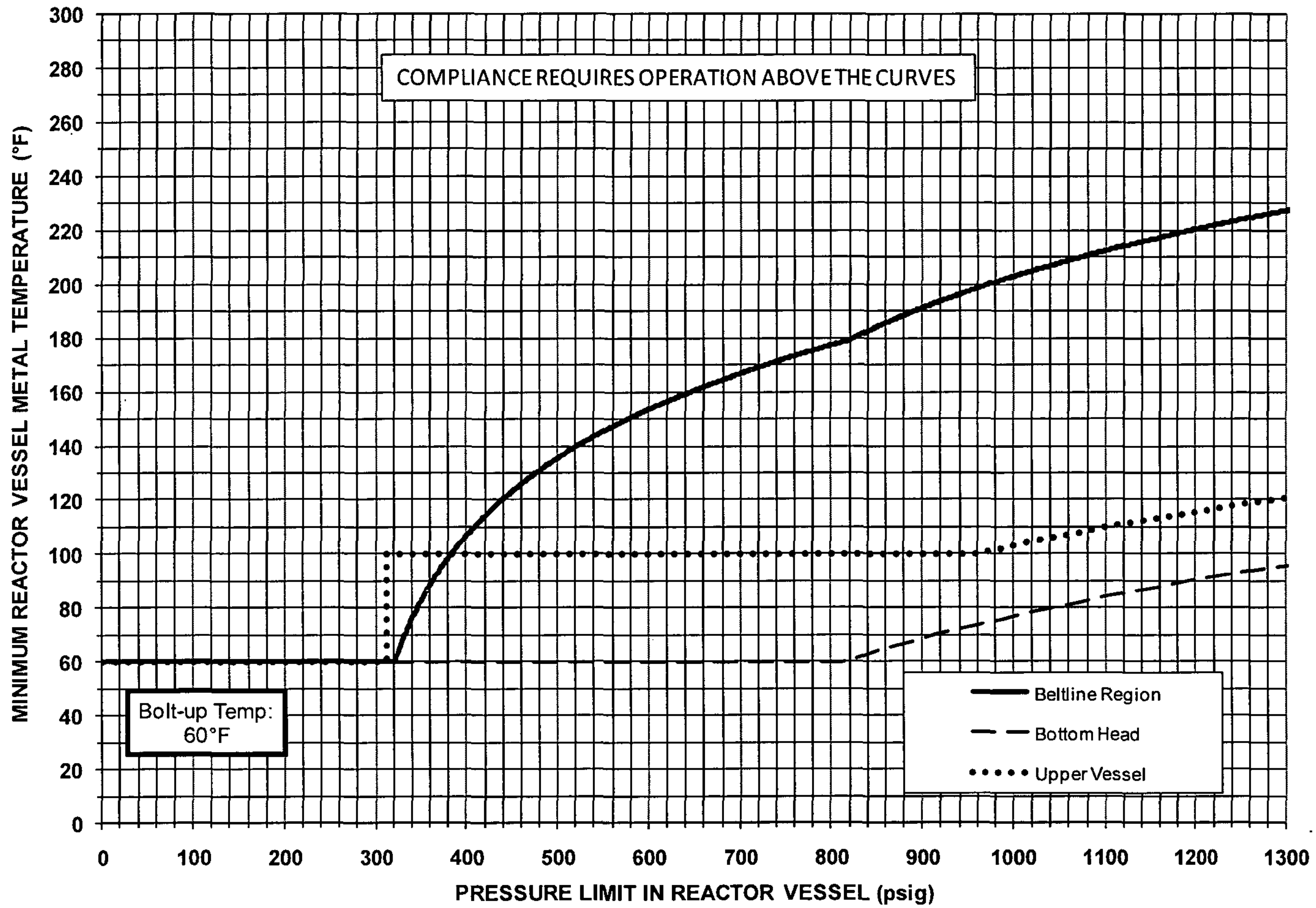


Figure 3: MNGP P-T Curve A (Hydrostatic Pressure and Leak Tests) for 54 EFPY

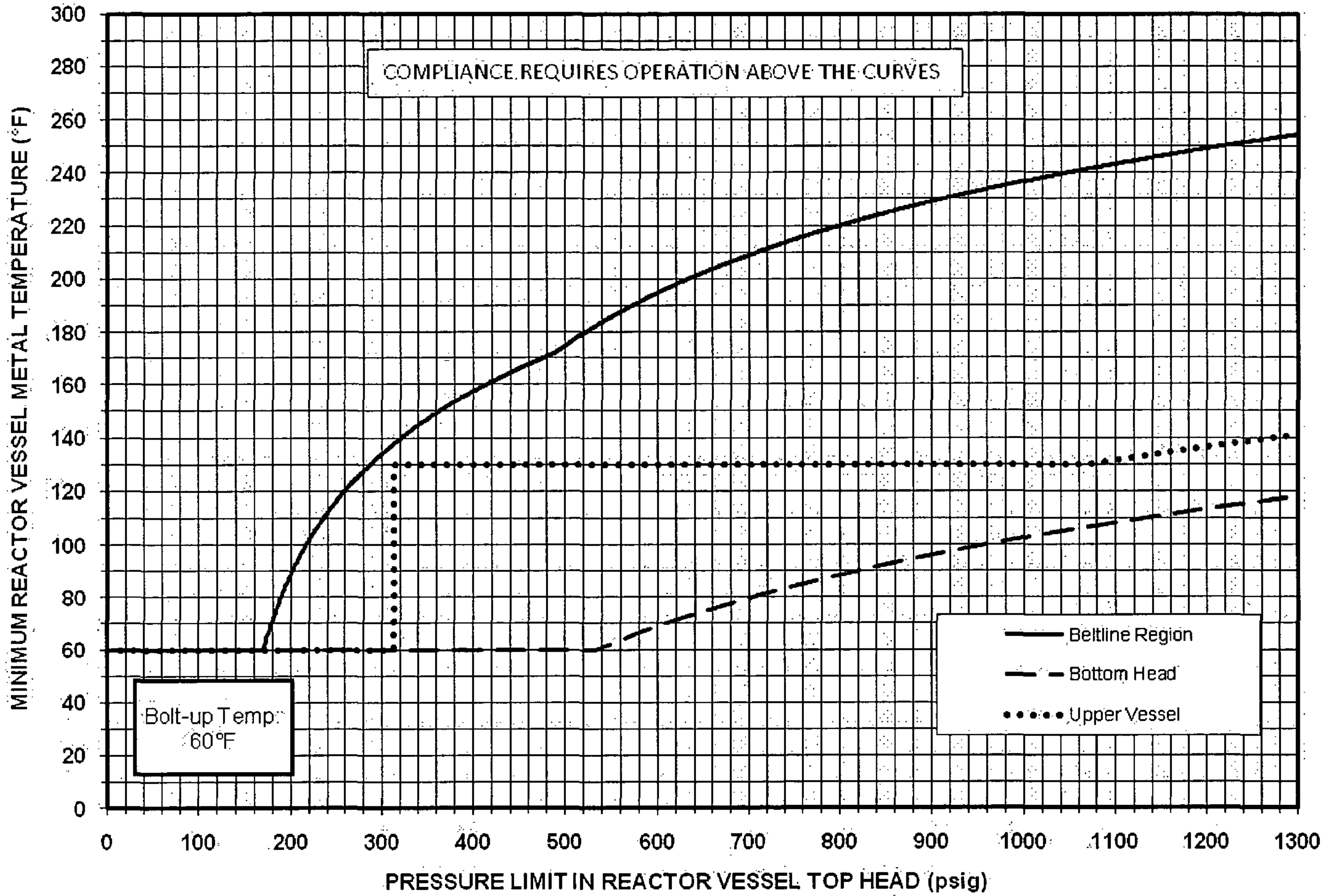


Figure 4. MNGP P-T Curve B (Normal Operation – Core Not Critical) for 54 EFPY

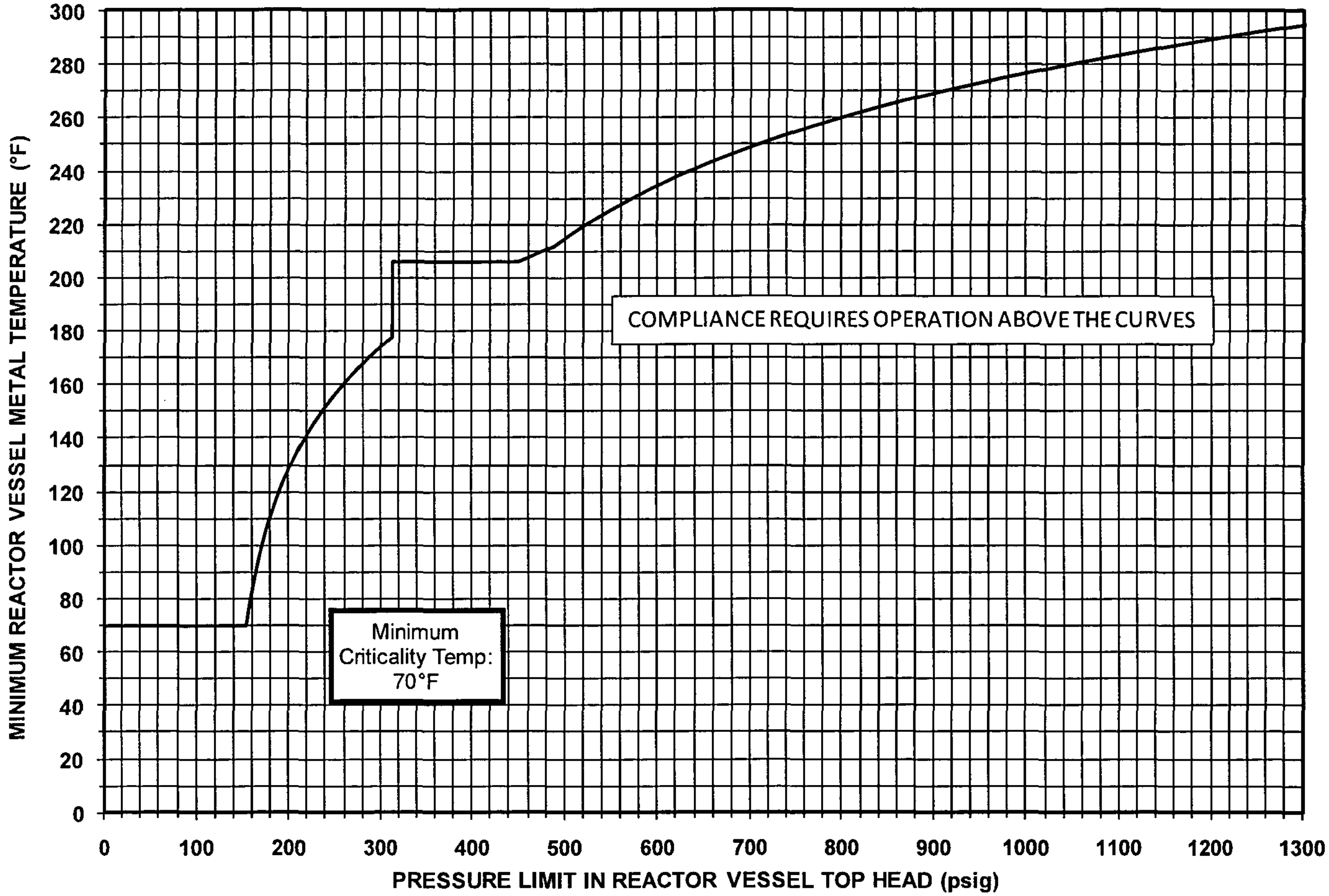


Figure 5. MNGP P-T Curve C (Normal Operation – Core Critical) for 54 EFPY

APPENDIX A

P-T CURVE INPUT LISTING

36 EFPY Input Listing:

P-T Curve Inputs

			Reference:
Instrument Uncertainty			
	Reactor Vessel Metal Temp	0 °F	Assumed
	Reactor Vessel Pressure	0 psig	Assumed
Geometry			
	Vessel Radius	103 in.	[7]
	Vessel Shell thickness	5.63 in.	[7]
	Bottom Head Thickness	5.9375 in.	[10]
	Bottom Head Radius	103.1875 in.	[10]
	Feedwater Nozzle Thickness	7.7317 in.	[11]
	Recirculation Inlet (N2) Nozzle Thickness	9.2884 in.	[12]
ART/RT_{NDT}			
36 EFPY	Limiting Beltine	**147.4** °F	[4]
	Limiting Bottom Head	26 °F	[6]
	Limiting Upper Vessel (Feedwater) RT_{NDT}	40 °F	[6]
	Flange Region (Boltup) RT_{NDT}	10 °F	[6]
	Limiting Recirculation Inlet (N2) Nozzle	104.1 °F	[4]
Safety Factor/Stress Concentration Factor			
	Core Not Critical (Curve B) Core Critical (Curve C)	2	[3]
	Pressure (Curve A)	1.5	[3]
	Lower Penetrations (SCF)	3	[3]
	Limiting Recirculation Inlet (N2) Nozzle (SCF)	-	
K_{It}			
	During Pressure Test (near isothermal conditions)	0 ksi√in	[3]
Water			
	Density	62.4 lb/ft^3	Assumed
	Pressure	1250 psig	[9]
	Full Water Elevation (pressure head)	758 in	[9]
	Hydrostatic Test Pressure	1563 psig	Calculated
	Static Head Pressure Adjustment	27.4 psig	Calculated
Assumed Temperature			
	Bolt Up Temperature	60 °F	[3]
	Increment	2 °F	Assumed
Rate of Temp Change			
	Heat Up and Cool Down Rate	100 °F/hour	[11]

40 EFPY Input Listing:

P-T Curve Inputs

			Reference:
Instrument Uncertainty			
	Reactor Vessel Metal Temp	0 °F	Assumed
	Reactor Vessel Pressure	0 psig	Assumed
Geometry			
	Vessel Radius	103 in.	[7]
	Vessel Shell thickness	5.63 in.	[7]
	Bottom Head Thickness	5.9375 in.	[10]
	Bottom Head Radius	103.1875 in.	[10]
	Feedwater Nozzle Thickness	7.7317 in.	[11]
	Recirculation Inlet (N2) Nozzle Thickness	9.2884 in.	[12]
ART/RT_{NDT}			
40 EFPY	Limiting Beltine	**156** °F	[4]
	Limiting Bottom Head	26 °F	[6]
	Limiting Upper Vessel (Feedwater) RT_{NDT}	40 °F	[6]
	Flange Region (Boltup) RT_{NDT}	10 °F	[6]
	Limiting Recirculation Inlet (N2) Nozzle	110 °F	[4]
Safety Factor/Stress Concentration Factor			
	Core Not Critical (Curve B) Core Critical (Curve C)	2	[3]
	Pressure (Curve A)	1.5	[3]
	Lower Penetrations (SCF)	3	[3]
	Limiting Recirculation Inlet (N2) Nozzle (SCF)	-	
K_{It}			
	During Pressure Test (near isothermal conditions)	0 ksi√in	[3]
Water			
	Density	62.4 lb/ft^3	Assumed
	Pressure	1250 psig	[9]
	Full Water Elevation (pressure head)	758 in	[9]
	Hydrostatic Test Pressure	1563 psig	Calculated
	Static Head Pressure Adjustment	27.4 psig	Calculated
Assumed Temperature			
	Bolt Up Temperature	60 °F	[3]
	Increment	2 °F	Assumed
Rate of Temp Change			
	Heat Up and Cool Down Rate	100 °F/hour	[11]

54 EFPY Input Listing:

P-T Curve Inputs

Instrument Uncertainty			**Reference:**
	Reactor Vessel Metal Temp	0 °F	Assumed
	Reactor Vessel Pressure	0 psig	Assumed
Geometry			
	Vessel Radius	103 in.	[7]
	Vessel Shell thickness	5.63 in.	[7]
	Bottom Head Thickness	5.9375 in.	[10]
	Bottom Head Radius	103.1875 in.	[10]
	Feedwater Nozzle Thickness	7.7317 in.	[11]
	Recirculation Inlet (N2) Nozzle Thickness	9.2884 in.	[12]
ART/RT_{NDT}			
54 EFPY	Limiting Beltine	186.6 °F	[4]
	Limiting Bottom Head	26 °F	[6]
	Limiting Upper Vessel (Feedwater) RT_{NDT}	40 °F	[6]
	Flange Region (Boltup) RT_{NDT}	10 °F	[6]
	Limiting Recirculation Inlet (N2) Nozzle	125.2 °F	[4]
Safety Factor/Stress Concentration Factor			
	Core Not Critical (Curve B) Core Critical (Curve C)	2	[3]
	Pressure (Curve A)	1.5	[3]
	Lower Penetrations (SCF)	3	[3]
	Limiting Recirculation Inlet (N2) Nozzle (SCF)	-	
K_{It}			
	During Pressure Test (near isothermal conditions)	0 ksi√in	[3]
Water			
	Density	62.4 lb/ft^3	Assumed
	Pressure	1250 psig	[9]
	Full Water Elevation (pressure head)	758 in	[9]
	Hydrostatic Test Pressure	1563 psig	Calculated
	Static Head Pressure Adjustment	27.4 psig	Calculated
Assumed Temperature			
	Bolt Up Temperature	60 °F	[3]
	Increment	2 °F	Assumed
Rate of Temp Change			
	Heat Up and Cool Down Rate	100 °F/hour	[11]

APPENDIX B

BOUNDING BELTLINE SUPPORTING ANALYSIS

Table B-1: MNGP, Beltline Region, Curve A, for 36 EFPY

Plant =	MNGP	
Component =	Beltline	
Vessel thickness, t =	5.630	inches
Vessel Radius, R =	103	inches
ART =	147.4	°F ======> 36 EFPY
K_{IT} =	0.00	(no thermal effects)
Safety Factor =	1.50	
M_m =	2.197	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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	36.81	24.54	60.0	0
60.0	36.81	24.54	60.0	583
62.0	36.96	24.64	62.0	586
64.0	37.11	24.74	64.0	588
66.0	37.27	24.85	66.0	591
68.0	37.44	24.96	68.0	594
70.0	37.61	25.07	70.0	596
72.0	37.79	25.19	72.0	599
74.0	37.98	25.32	74.0	602
76.0	38.17	25.45	76.0	606
78.0	38.37	25.58	78.0	609
80.0	38.59	25.72	80.0	613
82.0	38.81	25.87	82.0	616
84.0	39.03	26.02	84.0	620
86.0	39.27	26.18	86.0	624
88.0	39.52	26.35	88.0	628
90.0	39.78	26.52	90.0	632
92.0	40.05	26.70	92.0	637
94.0	40.33	26.88	94.0	641
96.0	40.62	27.08	96.0	646
98.0	40.92	27.28	98.0	651
100.0	41.23	27.49	100.0	657
102.0	41.56	27.71	102.0	662
104.0	41.90	27.94	104.0	668
106.0	42.26	28.17	106.0	673
108.0	42.63	28.42	108.0	680
110.0	43.01	28.68	110.0	686
112.0	43.41	28.94	112.0	693
114.0	43.83	29.22	114.0	700
116.0	44.26	29.51	116.0	707
118.0	44.72	29.81	118.0	714
120.0	45.19	30.12	120.0	722

Table B-1 Continued: MNGP, Beltline Region, Curve A, for 36 EFPY

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)
122.0	45.68	30.45	122.0	730
124.0	46.18	30.79	124.0	739
126.0	46.71	31.14	126.0	747
128.0	47.27	31.51	128.0	757
130.0	47.84	31.89	130.0	766
132.0	48.44	32.29	132.0	776
134.0	49.06	32.71	134.0	786
136.0	49.71	33.14	136.0	797
138.0	50.38	33.59	138.0	808
140.0	51.08	34.05	140.0	820
142.0	51.81	34.54	142.0	832
144.0	52.57	35.05	144.0	845
146.0	53.36	35.57	146.0	858
148.0	54.18	36.12	148.0	871
150.0	55.04	36.69	150.0	885
152.0	55.93	37.29	152.0	900
154.0	56.86	37.91	154.0	916
156.0	57.83	38.55	156.0	932
158.0	58.83	39.22	158.0	948
160.0	59.88	39.92	160.0	966
162.0	60.96	40.64	162.0	984
164.0	62.10	41.40	164.0	1,003
166.0	63.28	42.18	166.0	1,022
168.0	64.50	43.00	168.0	1,042
170.0	65.78	43.85	170.0	1,064
172.0	67.11	44.74	172.0	1,086
174.0	68.50	45.66	174.0	1,109
176.0	69.94	46.62	176.0	1,133
178.0	71.44	47.62	178.0	1,157
180.0	73.00	48.66	180.0	1,183
182.0	74.62	49.75	182.0	1,210
184.0	76.31	50.87	184.0	1,238
186.0	78.07	52.05	186.0	1,267
188.0	79.90	53.27	188.0	1,298
190.0	81.81	54.54	190.0	1,329

Table B-2: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve A, for 36 EFPY

Plant =	MNGP		
Component =	Limiting Recirculation Inlet (N2)		
ART =	104.10	°F ======>	36 EFPY
Vessel Radius, R =	103.00	inches	
Nozzle corner thickness, t =	9.29	inches, approximate	
K_{It} =	0.00	ksi*inch$^{1/2}$	
$K_{Ip\text{-}applied}$ =	74.36	ksi*inch$^{1/2}$	
Crack Depth, a =	2.32	inches	
Safety factor =	1.50		
Temperature Adjustment =	0.00	°F (applied after bolt-up, instrument uncertainty)	
Height of Water for a Full Vessel =	758.00	inches	
Pressure Adjustment =	27.37	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 Curve (°F)	Adjusted Pressure for P-T Curve (psig)
60.0	41.78	27.86	60.0	0
60.0	41.78	27.86	60.0	347
62.0	42.13	28.09	62.0	350
64.0	42.50	28.33	64.0	354
66.0	42.88	28.58	66.0	357
68.0	43.27	28.85	68.0	361
70.0	43.68	29.12	70.0	364
72.0	44.11	29.41	72.0	368
74.0	44.56	29.70	74.0	372
76.0	45.02	30.01	76.0	376
78.0	45.50	30.33	78.0	381
80.0	46.00	30.67	80.0	385
82.0	46.53	31.02	82.0	390
84.0	47.07	31.38	84.0	395
86.0	47.64	31.76	86.0	400
88.0	48.23	32.15	88.0	405
90.0	48.84	32.56	90.0	411
92.0	49.48	32.98	92.0	416
94.0	50.14	33.43	94.0	422
96.0	50.83	33.89	96.0	428
98.0	51.55	34.37	98.0	435
100.0	52.30	34.87	100.0	442
102.0	53.08	35.39	102.0	449
104.0	53.89	35.93	104.0	456
106.0	54.74	36.49	106.0	463
108.0	55.62	37.08	108.0	471
110.0	56.53	37.69	110.0	479

Table B-2 Continued: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve A, for 36 EFPY

Gauge Fluid Temperature (°F)	K_{Ic} (ksi*inch$^{1/2}$)	K_{Ip} (ksi*inch$^{1/2}$)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
112.0	57.48	38.32	112.0	488
114.0	58.47	38.98	114.0	497
116.0	59.51	39.67	116.0	506
118.0	60.58	40.39	118.0	516
120.0	61.70	41.13	120.0	526
122.0	62.86	41.91	122.0	536
124.0	64.07	42.71	124.0	547
126.0	65.33	43.55	126.0	558
128.0	66.64	44.43	128.0	570
130.0	68.01	45.34	130.0	582
132.0	69.43	46.28	132.0	595
134.0	70.90	47.27	134.0	608
136.0	72.44	48.30	136.0	622
138.0	74.04	49.36	138.0	636
140.0	75.71	50.47	140.0	651
142.0	77.45	51.63	142.0	667
144.0	79.25	52.83	144.0	683
146.0	81.13	54.09	146.0	700
148.0	83.09	55.39	148.0	718
150.0	85.12	56.75	150.0	736
152.0	87.24	58.16	152.0	755
154.0	89.45	59.63	154.0	775
156.0	91.74	61.16	156.0	795
158.0	94.13	62.76	158.0	817
160.0	96.62	64.41	160.0	839
162.0	99.21	66.14	162.0	862
164.0	101.90	67.93	164.0	886
166.0	104.71	69.80	166.0	911
168.0	107.62	71.75	168.0	938
170.0	110.66	73.77	170.0	965
172.0	113.82	75.88	172.0	993
174.0	117.11	78.08	174.0	1,023
176.0	120.54	80.36	176.0	1,053
178.0	124.10	82.73	178.0	1,085
180.0	127.81	85.21	180.0	1,119
182.0	131.67	87.78	182.0	1,153
184.0	135.69	90.46	184.0	1,189
186.0	139.87	93.25	186.0	1,227
188.0	144.23	96.15	188.0	1,266
190.0	148.76	99.17	190.0	1,306

Table B-3: MNGP, Beltline Region, Curve A, for 40 EFPY

Plant =	MNGP	
Component =	Beltline	
Vessel thickness, t =	5.630	inches
Vessel Radius, R =	103	inches
ART =	156.0	°F ======> 40 EFPY
K_{IT} =	0.00	(no thermal effects)
Safety Factor =	1.50	
M_m =	2.197	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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	36.24	24.16	60.0	0
60.0	36.24	24.16	60.0	574
62.0	36.36	24.24	62.0	576
64.0	36.49	24.33	64.0	578
66.0	36.63	24.42	66.0	580
68.0	36.77	24.51	68.0	582
70.0	36.91	24.61	70.0	585
72.0	37.06	24.71	72.0	587
74.0	37.22	24.81	74.0	590
76.0	37.39	24.92	76.0	593
78.0	37.56	25.04	78.0	596
80.0	37.73	25.16	80.0	598
82.0	37.92	25.28	82.0	602
84.0	38.11	25.41	84.0	605
86.0	38.31	25.54	86.0	608
88.0	38.52	25.68	88.0	612
90.0	38.74	25.83	90.0	615
92.0	38.96	25.98	92.0	619
94.0	39.20	26.13	94.0	623
96.0	39.44	26.30	96.0	627
98.0	39.70	26.47	98.0	631
100.0	39.97	26.64	100.0	635
102.0	40.24	26.83	102.0	640
104.0	40.53	27.02	104.0	645
106.0	40.83	27.22	106.0	650
108.0	41.14	27.43	108.0	655
110.0	41.46	27.64	110.0	660
112.0	41.80	27.87	112.0	666
114.0	42.15	28.10	114.0	672
116.0	42.52	28.34	116.0	678
118.0	42.90	28.60	118.0	684
120.0	43.29	28.86	120.0	691

Table B-3 Continued: MNGP, Beltline Region, Curve A, for 40 EFPY

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)
122.0	43.70	29.14	122.0	697
124.0	44.13	29.42	124.0	705
126.0	44.58	29.72	126.0	712
128.0	45.04	30.03	128.0	720
130.0	45.53	30.35	130.0	728
132.0	46.03	30.69	132.0	736
134.0	46.55	31.04	134.0	745
136.0	47.10	31.40	136.0	754
138.0	47.67	31.78	138.0	763
140.0	48.26	32.17	140.0	773
142.0	48.87	32.58	142.0	783
144.0	49.51	33.01	144.0	794
146.0	50.18	33.45	146.0	805
148.0	50.87	33.91	148.0	816
150.0	51.59	34.39	150.0	828
152.0	52.34	34.89	152.0	841
154.0	53.12	35.41	154.0	854
156.0	53.93	35.96	156.0	867
158.0	54.78	36.52	158.0	881
160.0	55.66	37.11	160.0	896
162.0	56.58	37.72	162.0	911
164.0	57.53	38.35	164.0	927
166.0	58.52	39.02	166.0	943
168.0	59.56	39.71	168.0	960
170.0	60.63	40.42	170.0	978
172.0	61.75	41.17	172.0	997
174.0	62.92	41.95	174.0	1,016
176.0	64.13	42.75	176.0	1,036
178.0	65.39	43.60	178.0	1,057
180.0	66.71	44.47	180.0	1,079
182.0	68.08	45.38	182.0	1,102
184.0	69.50	46.33	184.0	1,125
186.0	70.98	47.32	186.0	1,150
188.0	72.52	48.35	188.0	1,175
190.0	74.13	49.42	190.0	1,202
192.0	75.80	50.53	192.0	1,230
194.0	77.54	51.69	194.0	1,259
196.0	79.34	52.90	196.0	1,289
198.0	81.23	54.15	198.0	1,320

Table B-4: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve A, for 40 EFPY

Plant =	MNGP	
Component =	Limiting Recirculation Inlet (N2)	
ART =	110.00	°F ======> **40 EFPY**
Vessel Radius, R =	103.00	inches
Nozzle corner thickness, t =	9.29	inches, approximate
K_{It} =	0.00	ksi*inch$^{1/2}$
$K_{Ip\text{-}applied}$ =	74.36	ksi*inch$^{1/2}$
Crack Depth, a =	2.32	inches
Safety factor =	1.50	
Temperature Adjustment =	0.00	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.37	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 Curve (°F)	Adjusted Pressure for P-T Curve (psig)
60.0	40.83	27.22	60.0	0
60.0	40.83	27.22	60.0	339
62.0	41.14	27.43	62.0	341
64.0	41.46	27.64	64.0	344
66.0	41.80	27.87	66.0	347
68.0	42.15	28.10	68.0	351
70.0	42.52	28.34	70.0	354
72.0	42.90	28.60	72.0	357
74.0	43.29	28.86	74.0	361
76.0	43.70	29.14	76.0	364
78.0	44.13	29.42	78.0	368
80.0	44.58	29.72	80.0	372
82.0	45.04	30.03	82.0	376
84.0	45.53	30.35	84.0	381
86.0	46.03	30.69	86.0	385
88.0	46.55	31.04	88.0	390
90.0	47.10	31.40	90.0	395
92.0	47.67	31.78	92.0	400
94.0	48.26	32.17	94.0	405
96.0	48.87	32.58	96.0	411
98.0	49.51	33.01	98.0	417
100.0	50.18	33.45	100.0	422
102.0	50.87	33.91	102.0	429
104.0	51.59	34.39	104.0	435
106.0	52.34	34.89	106.0	442
108.0	53.12	35.41	108.0	449
110.0	53.93	35.96	110.0	456

Table B-4 Continued: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve A, for 40 EFPY

Gauge Fluid Temperature (°F)	K_{Ic} (ksi*inch$^{1/2}$)	K_{Ip} (ksi*inch$^{1/2}$)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
112.0	54.78	36.52	112.0	464
114.0	55.66	37.11	114.0	472
116.0	56.58	37.72	116.0	480
118.0	57.53	38.35	118.0	488
120.0	58.52	39.02	120.0	497
122.0	59.56	39.71	122.0	507
124.0	60.63	40.42	124.0	516
126.0	61.75	41.17	126.0	526
128.0	62.92	41.95	128.0	537
130.0	64.13	42.75	130.0	548
132.0	65.39	43.60	132.0	559
134.0	66.71	44.47	134.0	571
136.0	68.08	45.38	136.0	583
138.0	69.50	46.33	138.0	596
140.0	70.98	47.32	140.0	609
142.0	72.52	48.35	142.0	623
144.0	74.13	49.42	144.0	637
146.0	75.80	50.53	146.0	652
148.0	77.54	51.69	148.0	668
150.0	79.34	52.90	150.0	684
152.0	81.23	54.15	152.0	701
154.0	83.19	55.46	154.0	718
156.0	85.23	56.82	156.0	737
158.0	87.35	58.23	158.0	756
160.0	89.56	59.71	160.0	776
162.0	91.86	61.24	162.0	796
164.0	94.25	62.84	164.0	818
166.0	96.75	64.50	166.0	840
168.0	99.34	66.23	168.0	863
170.0	102.04	68.03	170.0	887
172.0	104.85	69.90	172.0	913
174.0	107.77	71.85	174.0	939
176.0	110.82	73.88	176.0	966
178.0	113.98	75.99	178.0	995
180.0	117.28	78.19	180.0	1,024
182.0	120.71	80.47	182.0	1,055
184.0	124.28	82.86	184.0	1,087
186.0	128.00	85.33	186.0	1,120
188.0	131.87	87.91	188.0	1,155
190.0	135.90	90.60	190.0	1,191
192.0	140.09	93.39	192.0	1,229
194.0	144.45	96.30	194.0	1,268
196.0	148.99	99.33	196.0	1,308

Table B-5: MNGP, Beltline Region, Curve A, for 54 EFPY

Plant =	MNGP	
Component =	Beltline	
Vessel thickness, t =	5.630	inches
Vessel Radius, R =	103	inches
ART =	186.6	°F ======> **54 EFPY**
K_{IT} =	0.00	(no thermal effects)
Safety Factor =	1.50	
M_m =	2.197	
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.4	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	34.85	23.23	60.0	0
60.0	34.85	23.23	60.0	551
62.0	34.92	23.28	62.0	552
64.0	34.99	23.32	64.0	553
66.0	35.06	23.37	66.0	554
68.0	35.13	23.42	68.0	555
70.0	35.21	23.48	70.0	557
72.0	35.30	23.53	72.0	558
74.0	35.38	23.59	74.0	559
76.0	35.47	23.65	76.0	561
78.0	35.56	23.71	78.0	562
80.0	35.66	23.77	80.0	564
82.0	35.76	23.84	82.0	566
84.0	35.86	23.91	84.0	567
86.0	35.97	23.98	86.0	569
88.0	36.09	24.06	88.0	571
90.0	36.20	24.14	90.0	573
92.0	36.33	24.22	92.0	575
94.0	36.45	24.30	94.0	577
96.0	36.59	24.39	96.0	579
98.0	36.72	24.48	98.0	582
100.0	36.87	24.58	100.0	584
102.0	37.02	24.68	102.0	587
104.0	37.17	24.78	104.0	589
106.0	37.34	24.89	106.0	592
108.0	37.50	25.00	108.0	595
110.0	37.68	25.12	110.0	598
112.0	37.86	25.24	112.0	601
114.0	38.05	25.37	114.0	604
116.0	38.25	25.50	116.0	607
118.0	38.46	25.64	118.0	610
120.0	38.67	25.78	120.0	614
122.0	38.90	25.93	122.0	618
124.0	39.13	26.09	124.0	622
126.0	39.37	26.25	126.0	626
128.0	39.62	26.41	128.0	630
130.0	39.88	26.59	130.0	634

Table B-5 Continued: MNGP, Beltline Region, Curve A, for 54 EFPY

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)
132.0	40.16	26.77	132.0	639
134.0	40.44	26.96	134.0	643
136.0	40.74	27.16	136.0	648
138.0	41.04	27.36	138.0	653
140.0	41.36	27.58	140.0	659
142.0	41.70	27.80	142.0	664
144.0	42.04	28.03	144.0	670
146.0	42.41	28.27	146.0	676
148.0	42.78	28.52	148.0	682
150.0	43.17	28.78	150.0	689
152.0	43.58	29.05	152.0	695
154.0	44.00	29.33	154.0	702
156.0	44.44	29.63	156.0	710
158.0	44.90	29.93	158.0	717
160.0	45.38	30.25	160.0	725
162.0	45.88	30.58	162.0	733
164.0	46.39	30.93	164.0	742
166.0	46.93	31.29	166.0	751
168.0	47.49	31.66	168.0	760
170.0	48.08	32.05	170.0	770
172.0	48.68	32.46	172.0	780
174.0	49.32	32.88	174.0	791
176.0	49.97	33.32	176.0	801
178.0	50.66	33.77	178.0	813
180.0	51.37	34.25	180.0	825
182.0	52.11	34.74	182.0	837
184.0	52.88	35.26	184.0	850
186.0	53.69	35.79	186.0	863
188.0	54.52	36.35	188.0	877
190.0	55.39	36.93	190.0	891
192.0	56.30	37.53	192.0	906
194.0	57.24	38.16	194.0	922
196.0	58.22	38.81	196.0	938
198.0	59.24	39.50	198.0	955
200.0	60.31	40.20	200.0	973
202.0	61.41	40.94	202.0	991
204.0	62.56	41.71	204.0	1,010
206.0	63.76	42.51	206.0	1,030
208.0	65.01	43.34	208.0	1,051
210.0	66.31	44.21	210.0	1,072
212.0	67.66	45.11	212.0	1,095
214.0	69.07	46.04	214.0	1,118
216.0	70.53	47.02	216.0	1,142
218.0	72.05	48.04	218.0	1,168
220.0	73.64	49.09	220.0	1,194
222.0	75.29	50.19	222.0	1,221
224.0	77.01	51.34	224.0	1,250
226.0	78.79	52.53	226.0	1,279
228.0	80.65	53.77	228.0	1,310

Table B-6: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve A, for 54 EFPY

Plant =	MNGP	
Component =	Limiting Recirculation Inlet (N2)	
ART =	125.20	°F ======> 54 EFPY
Vessel Radius, R =	103.00	inches
Nozzle corner thickness, t =	9.29	inches, approximate
K_{It} =	0.00	ksi*inch$^{1/2}$
$K_{Ip\text{-}applied}$ =	74.36	ksi*inch$^{1/2}$
Crack Depth, a =	2.32	inches
Safety factor =	1.50	
Temperature Adjustment =	0.00	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.37	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 Curve (°F)	Adjusted Pressure for P-T Curve (psig)
60.0	38.83	25.89	60.0	0
60.0	38.83	25.89	60.0	321
62.0	39.06	26.04	62.0	323
64.0	39.30	26.20	64.0	325
66.0	39.55	26.36	66.0	327
68.0	39.80	26.54	68.0	330
70.0	40.07	26.72	70.0	332
72.0	40.35	26.90	72.0	334
74.0	40.65	27.10	74.0	337
76.0	40.95	27.30	76.0	340
78.0	41.27	27.51	78.0	343
80.0	41.60	27.73	80.0	346
82.0	41.94	27.96	82.0	349
84.0	42.30	28.20	84.0	352
86.0	42.67	28.44	86.0	355
88.0	43.05	28.70	88.0	359
90.0	43.46	28.97	90.0	362
92.0	43.87	29.25	92.0	366
94.0	44.31	29.54	94.0	370
96.0	44.76	29.84	96.0	374
98.0	45.23	30.16	98.0	378
100.0	45.73	30.48	100.0	383
102.0	46.24	30.82	102.0	387
104.0	46.77	31.18	104.0	392
106.0	47.32	31.55	106.0	397
108.0	47.90	31.93	108.0	402
110.0	48.50	32.33	110.0	407
112.0	49.12	32.75	112.0	413
114.0	49.77	33.18	114.0	419
116.0	50.45	33.63	116.0	425
118.0	51.15	34.10	118.0	431
120.0	51.89	34.59	120.0	438

Table B-6 Continued: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve A, for 54 EFPY

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)
122.0	52.65	35.10	122.0	445
124.0	53.44	35.63	124.0	452
126.0	54.27	36.18	126.0	459
128.0	55.13	36.75	128.0	467
130.0	56.02	37.35	130.0	475
132.0	56.95	37.97	132.0	483
134.0	57.92	38.62	134.0	492
136.0	58.93	39.29	136.0	501
138.0	59.98	39.99	138.0	510
140.0	61.08	40.72	140.0	520
142.0	62.21	41.48	142.0	530
144.0	63.40	42.27	144.0	541
146.0	64.63	43.09	146.0	552
148.0	65.91	43.94	148.0	564
150.0	67.25	44.83	150.0	576
152.0	68.64	45.76	152.0	588
154.0	70.08	46.72	154.0	601
156.0	71.59	47.73	156.0	614
158.0	73.16	48.77	158.0	629
160.0	74.79	49.86	160.0	643
162.0	76.48	50.99	162.0	658
164.0	78.25	52.17	164.0	674
166.0	80.09	53.39	166.0	691
168.0	82.00	54.67	168.0	708
170.0	83.99	56.00	170.0	726
172.0	86.07	57.38	172.0	744
174.0	88.22	58.82	174.0	764
176.0	90.47	60.31	176.0	784
178.0	92.81	61.87	178.0	805
180.0	95.24	63.49	180.0	827
182.0	97.77	65.18	182.0	849
184.0	100.41	66.94	184.0	873
186.0	103.15	68.77	186.0	897
188.0	106.00	70.67	188.0	923
190.0	108.98	72.65	190.0	950
192.0	112.07	74.71	192.0	977
194.0	115.29	76.86	194.0	1,006
196.0	118.64	79.09	196.0	1,036
198.0	122.12	81.42	198.0	1,068
200.0	125.75	83.83	200.0	1,100
202.0	129.53	86.35	202.0	1,134
204.0	133.46	88.97	204.0	1,169
206.0	137.55	91.70	206.0	1,206
208.0	141.81	94.54	208.0	1,244
210.0	146.24	97.50	210.0	1,284
212.0	150.86	100.57	212.0	1,325

Table B-7: MNGP, Beltline Region, Curve B, for 54 EFPY

Plant =	MNGP		
Component =	Beltline		
Vessel thickness, t =	5.630	inches	
Vessel Radius, R =	103	inches	
ART =	186.6	°F ======>	54 EFPY
K_{It} =	7.17	ksi*inch$^{1/2}$	
Safety Factor =	2.00		
M_m =	2.197		
Temperature Adjustment =	0.0	°F (applied after bolt-up, instrument uncertainty)	
Height of Water for a Full Vessel =	758.00	inches	
Pressure Adjustment =	27.4	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	34.85	13.84	60.0	0
60.0	34.85	13.84	60.0	317
62.0	34.92	13.87	62.0	318
64.0	34.99	13.91	64.0	319
66.0	35.06	13.95	66.0	320
68.0	35.13	13.98	68.0	321
70.0	35.21	14.02	70.0	321
72.0	35.30	14.06	72.0	323
74.0	35.38	14.11	74.0	324
76.0	35.47	14.15	76.0	325
78.0	35.56	14.20	78.0	326
80.0	35.66	14.25	80.0	327
82.0	35.76	14.30	82.0	328
84.0	35.86	14.35	84.0	330
86.0	35.97	14.40	86.0	331
88.0	36.09	14.46	88.0	332
90.0	36.20	14.52	90.0	334
92.0	36.33	14.58	92.0	335
94.0	36.45	14.64	94.0	337
96.0	36.59	14.71	96.0	339
98.0	36.72	14.78	98.0	340
100.0	36.87	14.85	100.0	342
102.0	37.02	14.93	102.0	344
104.0	37.17	15.00	104.0	346
106.0	37.34	15.08	106.0	348
108.0	37.50	15.17	108.0	350
110.0	37.68	15.26	110.0	352
112.0	37.86	15.35	112.0	354
114.0	38.05	15.44	114.0	357
116.0	38.25	15.54	116.0	359
118.0	38.46	15.65	118.0	362
120.0	38.67	15.75	120.0	365
122.0	38.90	15.86	122.0	367
124.0	39.13	15.98	124.0	370
126.0	39.37	16.10	126.0	373
128.0	39.62	16.23	128.0	376
130.0	39.88	16.36	130.0	380
132.0	40.16	16.49	132.0	383
134.0	40.44	16.64	134.0	387
136.0	40.74	16.78	136.0	390
138.0	41.04	16.94	138.0	394
140.0	41.36	17.10	140.0	398

Table B-7: Continued: MNGP, Beltline Region, Curve B, for 54 EFPY

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	41.70	17.27	142.0	402
144.0	42.04	17.44	144.0	406
146.0	42.41	17.62	146.0	411
148.0	42.78	17.81	148.0	416
150.0	43.17	18.00	150.0	420
152.0	43.58	18.21	152.0	426
154.0	44.00	18.42	154.0	431
156.0	44.44	18.64	156.0	436
158.0	44.90	18.87	158.0	442
160.0	45.38	19.11	160.0	448
162.0	45.88	19.35	162.0	454
164.0	46.39	19.61	164.0	461
166.0	46.93	19.88	166.0	467
168.0	47.49	20.16	168.0	474
170.0	48.08	20.45	170.0	481
172.0	48.68	20.76	172.0	489
174.0	49.32	21.07	174.0	497
176.0	49.97	21.40	176.0	505
178.0	50.66	21.75	178.0	514
180.0	51.37	22.10	180.0	522
182.0	52.11	22.47	182.0	532
184.0	52.88	22.86	184.0	541
186.0	53.69	23.26	186.0	551
188.0	54.52	23.68	188.0	562
190.0	55.39	24.11	190.0	572
192.0	56.30	24.57	192.0	584
194.0	57.24	25.04	194.0	595
196.0	58.22	25.53	196.0	608
198.0	59.24	26.04	198.0	620
200.0	60.31	26.57	200.0	634
202.0	61.41	27.12	202.0	647
204.0	62.56	27.70	204.0	662
206.0	63.76	28.30	206.0	677
208.0	65.01	28.92	208.0	692
210.0	66.31	29.57	210.0	708
212.0	67.66	30.25	212.0	725
214.0	69.07	30.95	214.0	743
216.0	70.53	31.68	216.0	761
218.0	72.05	32.44	218.0	780
220.0	73.64	33.24	220.0	799
222.0	75.29	34.06	222.0	820
224.0	77.01	34.92	224.0	841
226.0	78.79	35.81	226.0	864
228.0	80.65	36.74	228.0	887
230.0	82.59	37.71	230.0	911
232.0	84.61	38.72	232.0	936
234.0	86.70	39.77	234.0	962
236.0	88.89	40.86	236.0	989
238.0	91.16	42.00	238.0	1,017
240.0	93.53	43.18	240.0	1,047
242.0	95.99	44.41	242.0	1,077
244.0	98.55	45.69	244.0	1,109
246.0	101.22	47.03	246.0	1,142
248.0	103.99	48.41	248.0	1,177
250.0	106.88	49.86	250.0	1,213
252.0	109.89	51.36	252.0	1,250
254.0	113.02	52.93	254.0	1,289
256.0	116.28	54.56	256.0	1,330

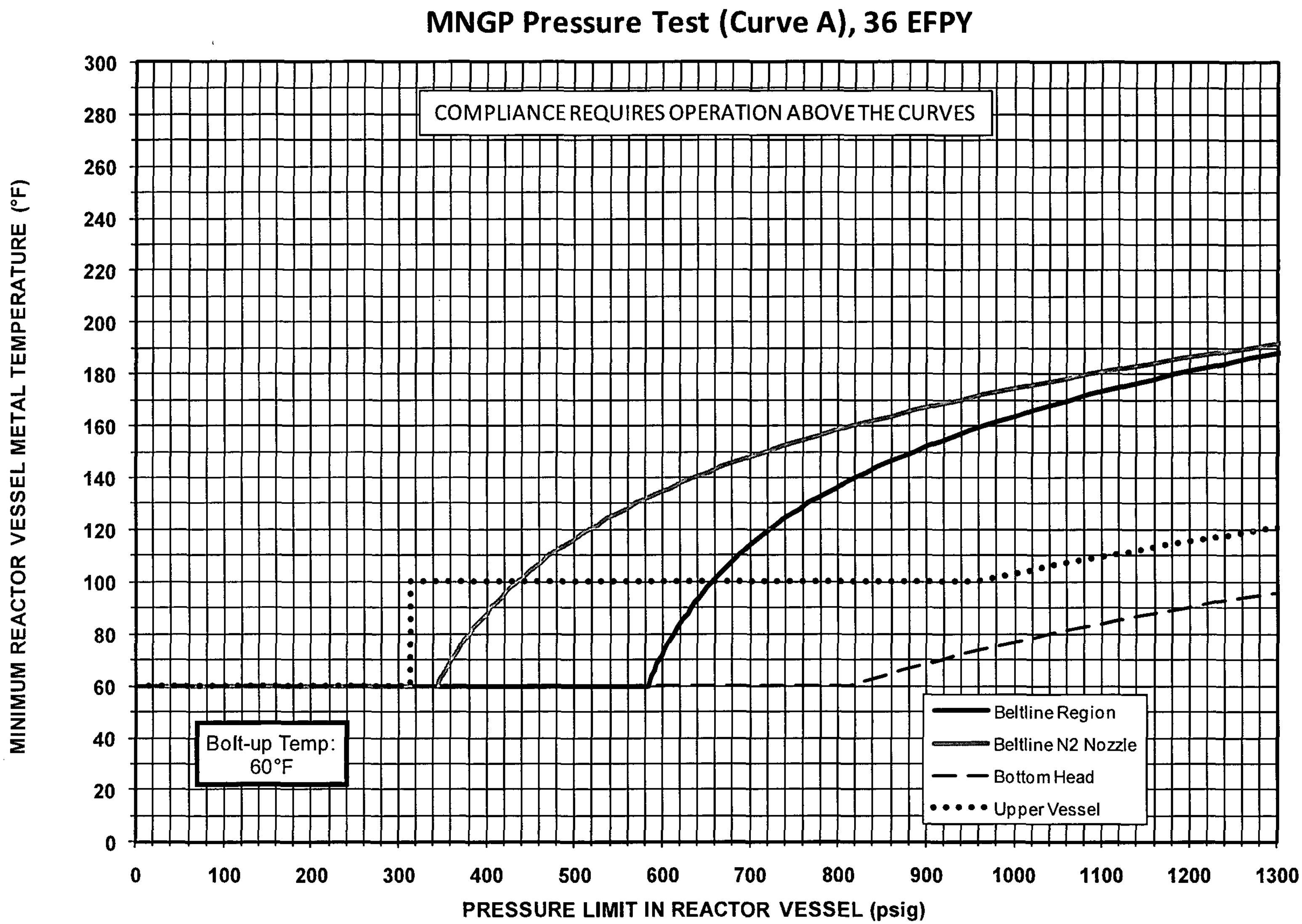
Table B-8: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve B, for 54 EFPY

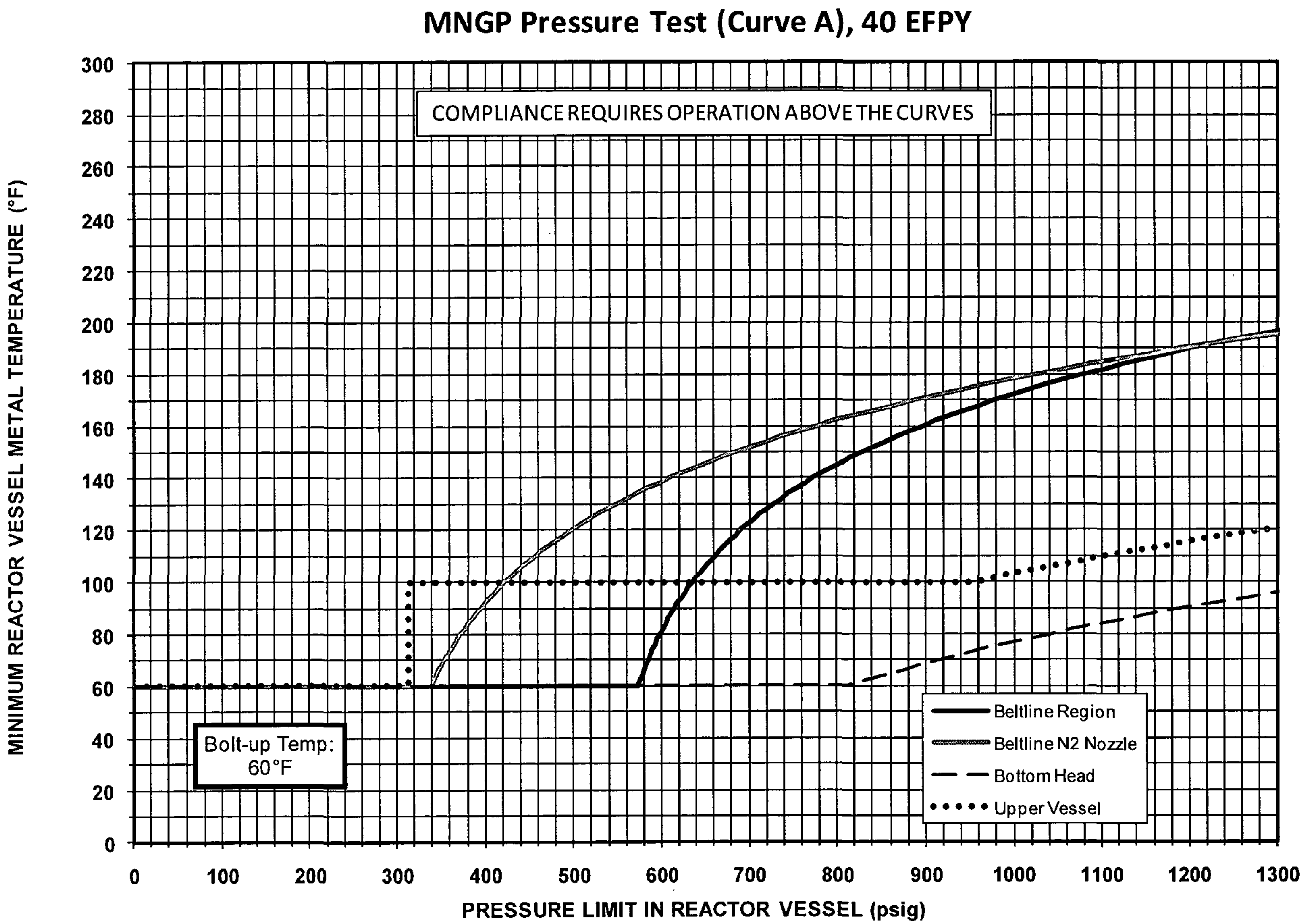
Plant =	MNGP	
Component =	Limiting Recirculation Inlet (N2) Nozzle	
ART =	125.20	°F ======> 54 EFPY
Vessel Radius, R =	103.00	inches
Nozzle corner thickness, t =	9.29	inches, approximate
K_{It} =	9.45	ksi*inch$^{1/2}$
$K_{Ip\text{-applied}}$ =	74.36	ksi*inch$^{1/2}$
Crack Depth, a =	2.32	inches
Safety factor =	2.00	
Temperature Adjustment =	0.00	°F (applied after bolt-up, instrument uncertainty)
Height of Water for a Full Vessel =	758.00	inches
Pressure Adjustment =	27.37	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)

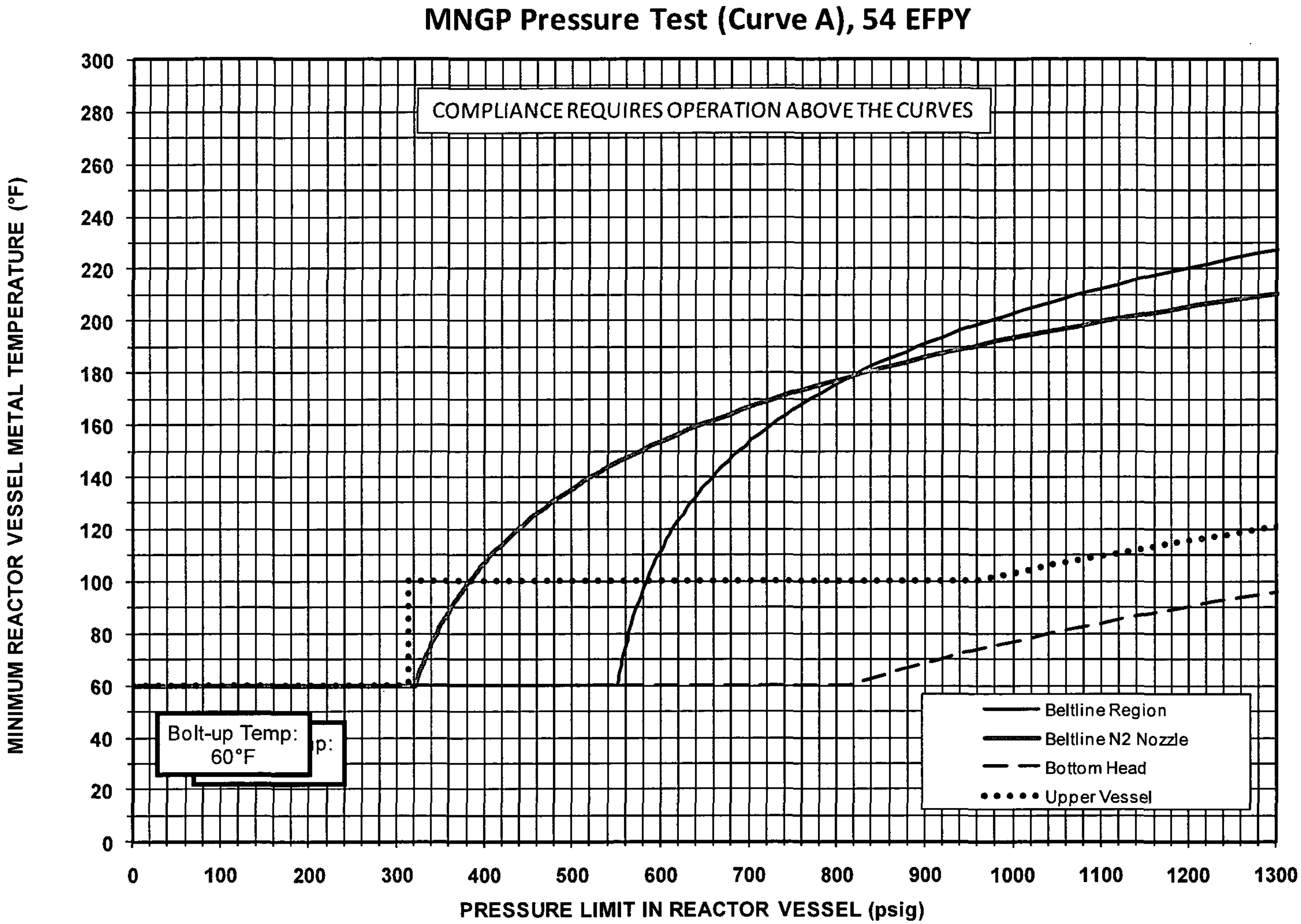
Gauge Fluid Temperature (°F)	K_{Ic} (ksi*inch$^{1/2}$)	K_{Ip} (ksi*inch$^{1/2}$)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
60.0	38.83	14.69	60.0	0
60.0	38.83	14.69	60.0	170
62.0	39.06	14.80	62.0	172
64.0	39.30	14.92	64.0	173
66.0	39.55	15.05	66.0	175
68.0	39.80	15.18	68.0	177
70.0	40.07	15.31	70.0	179
72.0	40.35	15.45	72.0	180
74.0	40.65	15.60	74.0	182
76.0	40.95	15.75	76.0	184
78.0	41.27	15.91	78.0	187
80.0	41.60	16.07	80.0	189
82.0	41.94	16.24	82.0	191
84.0	42.30	16.42	84.0	193
86.0	42.67	16.61	86.0	196
88.0	43.05	16.80	88.0	199
90.0	43.46	17.00	90.0	201
92.0	43.87	17.21	92.0	204
94.0	44.31	17.43	94.0	207
96.0	44.76	17.65	96.0	210
98.0	45.23	17.89	98.0	213
100.0	45.73	18.14	100.0	217
102.0	46.24	18.39	102.0	220
104.0	46.77	18.66	104.0	224
106.0	47.32	18.93	106.0	227
108.0	47.90	19.22	108.0	231
110.0	48.50	19.52	110.0	235
112.0	49.12	19.83	112.0	239
114.0	49.77	20.16	114.0	244
116.0	50.45	20.50	116.0	248
118.0	51.15	20.85	118.0	253
120.0	51.89	21.22	120.0	258
122.0	52.65	21.60	122.0	263
124.0	53.44	21.99	124.0	268
126.0	54.27	22.41	126.0	274
128.0	55.13	22.84	128.0	280
130.0	56.02	23.28	130.0	286

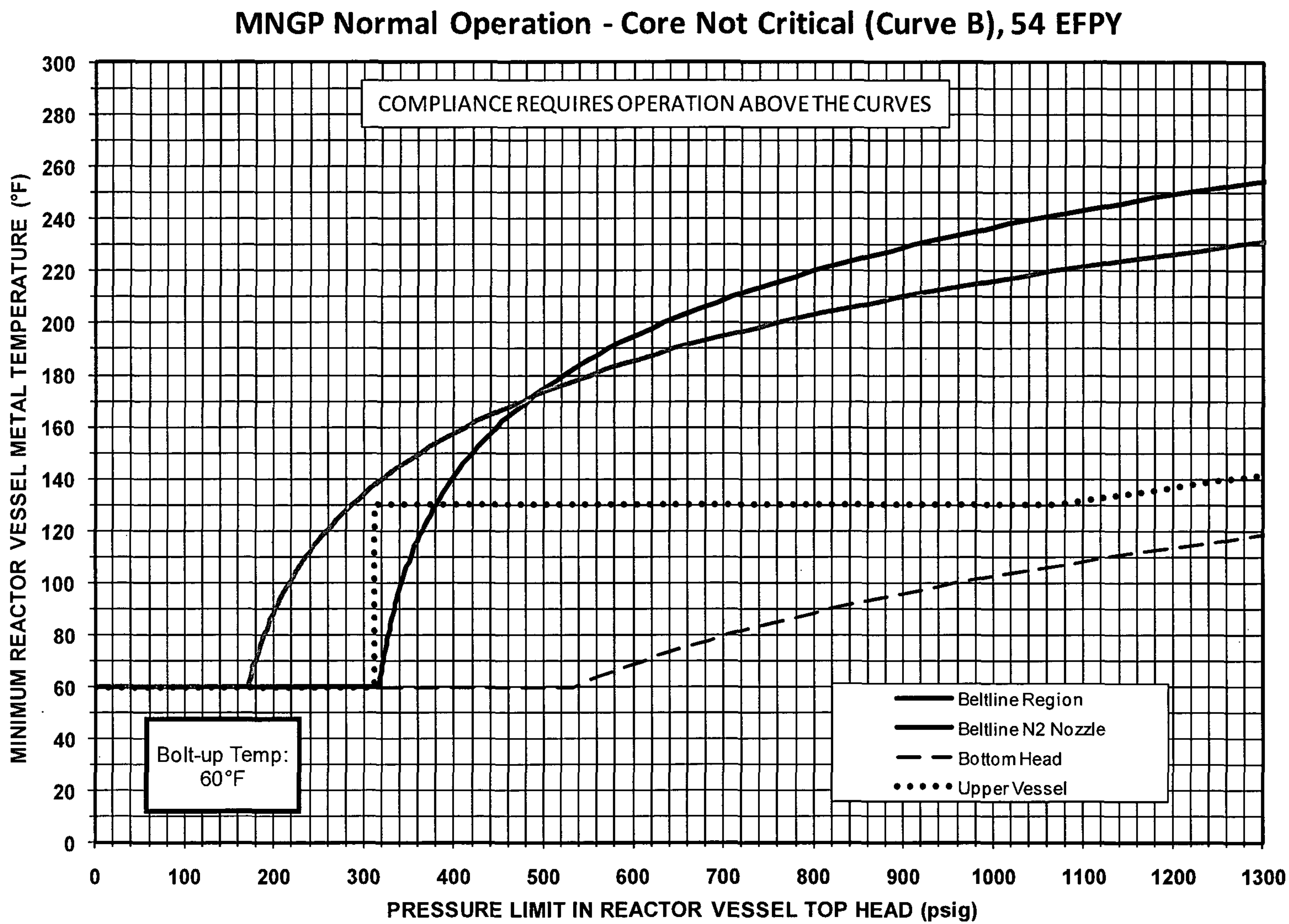
Table B-8 Cont: MNGP, Recirculation Inlet (N2) Nozzle Beltline Region, Curve B, for 54 EFPY

Gauge Fluid Temperature (°F)	K_{Ic} (ksi*inch$^{1/2}$)	K_{Ip} (ksi*inch$^{1/2}$)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
132.0	56.95	23.75	132.0	292
134.0	57.92	24.23	134.0	299
136.0	58.93	24.74	136.0	305
138.0	59.98	25.26	138.0	312
140.0	61.08	25.81	140.0	320
142.0	62.21	26.38	142.0	327
144.0	63.40	26.97	144.0	335
146.0	64.63	27.59	146.0	344
148.0	65.91	28.23	148.0	352
150.0	67.25	28.90	150.0	361
152.0	68.64	29.59	152.0	371
154.0	70.08	30.31	154.0	380
156.0	71.59	31.07	156.0	390
158.0	73.16	31.85	158.0	401
160.0	74.79	32.67	160.0	412
162.0	76.48	33.51	162.0	423
164.0	78.25	34.40	164.0	435
166.0	80.09	35.32	166.0	448
168.0	82.00	36.27	168.0	460
170.0	83.99	37.27	170.0	474
172.0	86.07	38.31	172.0	488
174.0	88.22	39.38	174.0	502
176.0	90.47	40.51	176.0	517
178.0	92.81	41.68	178.0	533
180.0	95.24	42.89	180.0	549
182.0	97.77	44.16	182.0	567
184.0	100.41	45.48	184.0	584
186.0	103.15	46.85	186.0	603
188.0	106.00	48.27	188.0	622
190.0	108.98	49.76	190.0	642
192.0	112.07	51.31	192.0	663
194.0	115.29	52.92	194.0	684
196.0	118.64	54.59	196.0	707
198.0	122.12	56.33	198.0	730
200.0	125.75	58.15	200.0	755
202.0	129.53	60.04	202.0	780
204.0	133.46	62.00	204.0	806
206.0	137.55	64.05	206.0	834
208.0	141.81	66.18	208.0	863
210.0	146.24	68.39	210.0	892
212.0	150.86	70.70	212.0	923
214.0	155.66	73.10	214.0	956
216.0	160.66	75.60	216.0	989
218.0	165.86	78.20	218.0	1,024
220.0	171.27	80.91	220.0	1,061
222.0	176.91	83.73	222.0	1,099
224.0	182.77	86.66	224.0	1,138
226.0	188.88	89.71	226.0	1,179
228.0	195.23	92.89	228.0	1,222
230.0	201.84	96.19	230.0	1,266
232.0	208.72	99.63	232.0	1,313


MNGP Pressure Test (Curve A), 36 EFPY
COMPLIANCE REQUIRES OPERATION ABOVE THE CURVES
MINIMUM REACTOR VESSEL METAL TEMPERATURE (°F)
PRESSURE LIMIT IN REACTOR VESSEL (psig)
Bolt-up Temp: 60°F
Beltline Region
Beltline N2 Nozzle
Bottom Head
Upper Vessel
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300


MNGP Pressure Test (Curve A), 40 EFPY
COMPLIANCE REQUIRES OPERATION ABOVE THE CURVES
MINIMUM REACTOR VESSEL METAL TEMPERATURE (°F)
PRESSURE LIMIT IN REACTOR VESSEL (psig)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
Bolt-up Temp:
60°F
Beltline Region
Beltline N2 Nozzle
Bottom Head
Upper Vessel


MNGP Pressure Test (Curve A), 54 EFPY
COMPLIANCE REQUIRES OPERATION ABOVE THE CURVES
MINIMUM REACTOR VESSEL METAL TEMPERATURE (°F)
PRESSURE LIMIT IN REACTOR VESSEL (psig)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
Bolt-up Temp: 60°F
Beltline Region
Beltline N2 Nozzle
Bottom Head
Upper Vessel


MNGP Normal Operation - Core Not Critical (Curve B), 54 EFPY
COMPLIANCE REQUIRES OPERATION ABOVE THE CURVES
MINIMUM REACTOR VESSEL METAL TEMPERATURE (°F)
PRESSURE LIMIT IN REACTOR VESSEL TOP HEAD (psig)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
Bolt-up Temp: 60°F
Beltline Region
Beltline N2 Nozzle
Bottom Head
Upper Vessel

ENCLOSURE 9

MONTICELLO NUCLEAR GENERATING PLANT

LICENSE AMENDMENT REQUEST

REVISE THE TECHNICAL SPECIFICATIONS TO INCLUDE A
PRESSURE TEMPERATURE LIMITS REPORT

CALCULATION CA 11-003

AFFADAVITS FROM STRUCTURAL INTEGRITY ASSOCIATES, INC AND EPRI
FOR THE PROPIETARY CALCULATION EVALUATION OF ADJUSTED
REFERENCE TEMPERATURES AND REFERENCE TEMPERATURE SHIFTS

(SIA No. 1000847.301)

PROPRIETARY VERSION

(5 pages follow)

Structural Integrity Associates, Inc.®

5215 Hellyer Ave.
Suite 210
San Jose, CA 95138-1025
Phone: 408-978-8200
Fax: 408-978-8964
www.structint.com

August 19, 2011

AFFIDAVIT

I, Marcos Legaspi Herrera, state as follows:

(1) I am a Vice President of Structural Integrity Associates, Inc. (SI) and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in SI Calculation 1000847.301, Rev. 2, "Evaluation of Adjusted Reference Temperatures and Reference Temperature Shifts." This calculation is to be treated as SI proprietary information, because it contains significant information that is deemed proprietary and confidential to Electric Power Research Institute, Inc. (EPRI). EPRI design input information was provided to SI in strictest confidence so that we could generate the aforementioned calculation on behalf of SI's client, Xcel Energy, Inc..

Paragraph 3 of this Affidavit provides the basis for the proprietary determination.

(3) SI is making this application for withholding of proprietary information on the basis that such information was provided to SI under the protection of a Proprietary/Confidentiality and Nondisclosure Agreement between SI and EPRI. In a separate Affidavit requesting withholding of such proprietary information prepared by EPRI, EPRI relies upon the exemption of disclosure set forth in NRC Regulation 10 CFR 2.390(a)(4) pertaining to "withholding based upon privileged and confidential trade secrets or commercial or financial information" (Exemption 4). As delineated in EPRI's Affidavit, the material for which exemption from disclosure is herein sought is considered proprietary for the following reasons (taken directly from Items a, b, d, and e of EPRI's Affidavit):

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

b) EPRI considers the Proprietary Information contained therein to constitute trade secrets of EPRI. As such, EPRI holds the Information in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Information. EPRI made a substantial economic investment to develop the Proprietary Information and, by prohibiting public disclosure, EPRI derives an economic benefit in the form of licensing royalties and other additional fees from the confidential nature of the Proprietary Information. If the Proprietary Information were publicly available to consultants and/or other businesses providing services in the electric and/or nuclear power industry, they would be able to use the Proprietary Information for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Proprietary Information.

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

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

Public disclosure of the information sought to be withheld is likely to cause substantial harm to EPRI with which SI has established a Proprietary/Confidentiality and Nondisclosure Agreement.

I declare under penalty of perjury that the above information and request are true, correct, and complete to the best of my knowledge, information, and belief.

Executed at San Jose, California on this 19th day of August, 2011.

Marcos Legaspi Herrera, P.E.
Vice President
Nuclear Plant Services

State of California

County of Santa Clara

Subscribed and sworn to (or affirmed) before me on this 19th day of August, 2011,
Date Month Year

by

(1) Maros Legaspi Herrera
Name of Signer

proved to me on the basis of satisfactory evidence to be the person who appeared before me (.) (x)
(and

(2) ______________________
Name of Signer

proved to me on the basis of satisfactory evidence to be the person who appeared before me.)

C. METZGER
Commission # 1866327
Notary Public - California
Santa Clara County
My Comm. Expires Sep 27, 2013

Place Notary Seal and/or Stamp Above

Signature ______________________
Signature of Notary Public

ELECTRIC POWER RESEARCH INSTITUTE

AFFIDAVIT

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

"Monticello P-T Curves Revision According to the PTLR Methodology"
Structural Integrity Associates Report No: 1000847.301
Revision 2, Project No: 1100730, August 2011

I, David J. Modeen, being duly sworn, depose and state as follows:

I am the Director, External Affairs, Nuclear Sector at Electric Power Research Institute, Inc. whose principal office is located at 1300 W WT Harris Blvd, Charlotte North Carolina ("EPRI") and I have been specifically delegated responsibility for the above-listed report that contains EPRI Proprietary Information that is sought under this Affidavit to be withheld "Proprietary Information". I am authorized to apply to the U.S. Nuclear Regulatory Commission ("NRC") for the withholding of the Proprietary Information on behalf of EPRI.

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

Withholding Based Upon Privileged And Confidential Trade Secrets Or Commercial Or Financial Information:

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

b. EPRI considers the Proprietary Information contained therein to constitute trade secrets of EPRI. As such, EPRI holds the Information in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Information. EPRI made a substantial economic investment to develop the Proprietary Information and, by prohibiting public disclosure, EPRI derives an economic benefit in the form of licensing royalties and other additional fees from the confidential nature of the Proprietary Information. If the Proprietary Information were publicly available to consultants and/or other businesses providing services in the electric and/or nuclear power industry, they would be able to use the Proprietary Information for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Proprietary Information.

c. EPRI's classification of the Proprietary Information as trade secrets is justified by the Uniform Trade Secrets Act which California adopted in 1984 and a version of which has been adopted by over forty states. The California Uniform Trade Secrets Act, California Civil Code §§3426 – 3426.11, defines a "trade secret" as follows:

> "'Trade secret' means information, including a formula, pattern, compilation, program device, method, technique, or process, that:
>
> (1) Derives independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use; and

(2) Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy."

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

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

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

Executed at 1300 W WT Harris Blvd being the premises and place of business of Electric Power Research Institute, Inc.

Date: Aug 4, 2011

David J. Modeen

(State of North Carolina)
(County of Mecklenburg)

Subscribed and sworn to (or affirmed) before me on this 4th day of August, 2011, by David J. Modeen, proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

Signature Sheryl R. Stogner (Seal)

My Commission Expires 25th day of August, 2014