Xcel Energy®

Monticello Nuclear Generating Plant
2807 W County Road 75
Monticello, MN 55362

August 28, 2014

L-MT-14-076
Technical Specification 5.6.5

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Monticello Nuclear Generating Plant
Docket No. 50-263
Renewed Facility Operating License No. DPR-22

Submittal of the Pressure and Temperature Limits Report (PTLR), Revision 1

Northern States Power Company – Minnesota (NSPM), a Minnesota corporation, doing business as Xcel Energy, is providing in accordance with Technical Specification 5.6.5, "Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR),"a revised PTLR for the Monticello Nuclear Generating Plant. The PTLR provides the RCS pressure and temperature limits for heatup, cooldown, low temperature operation, criticality, and hydrostatic testing established applying U.S. Nuclear Regulatory Commission approved methodologies. The current PTLR has been updated to reflect operation under a vacuum in the reactor pressure vessel.

Summary of Commitments

This letter proposes no new commitments and does not revise any existing commitments.

Should you have questions regarding this letter, please contact Mr. Richard Loeffler at (763) 295-1247.

Executed on August 28, 2014.

Karen D. Fili

Karen D. Fili
Site Vice President, Monticello Nuclear Generating Plant
Northern States Power Company – Minnesota

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Monticello, USNRC
Resident Inspector, Monticello, USNRC
Minnesota Department of Commerce

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ENCLOSURE

MONTICELLO NUCLEAR GENERATING PLANT

PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

UP TO 54 EFFECTIVE FULL-POWER YEARS (EFPY)

REVISION 1

(39 pages follow)

Xcel Energy®

Monticello Nuclear Generating Plant

Pressure and Temperature Limits Report (PTLR) up to 54 Effective Full-Power Years (EFPY)

Technical Lead:	[signature] Wynter McGruder	Date: 8/5/14
Technical Review:	[signature] Jim Bridgeman	Date: 8/5/14
Program Manager:	[signature] for Gary Sherwood Gary Sherwood	Date: 8/5/14
Director of Engineering:	[signature] Mark Ligenfelter	Date: 8/5/14

Table of Contents

REVISION RECORD

Revision No.	Revision Description
0	Initial Issue
1	Revision to address operation of the RPV under a vacuum.

1.0 Purpose

The purpose of the Monticello Nuclear Generating Plant (MNGP) Pressure and Temperature Limits Report (PTLR) is to present operating limits relating to:

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

This report has been prepared in accordance with the requirements of Reference [1], Licensing Topical Report SIR-05-044-A, Revision 0, April 2007.

2.0 Applicability

This report is applicable to the MNGP RPV up to 54 Effective Full-Power Years (EFPY).

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

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

3.0 Methodology

The limits in this report were derived as follows:

1. The methodology used is in accordance with Reference [1], which has been approved for BWR use by the NRC.

2. The neutron fluence is calculated in accordance with NRC Regulatory Guide 1.190 (RG 1.190) [2], as documented in Reference [3].

3. The adjusted reference temperature (ART) values for the limiting beltline materials are calculated in accordance with NRC Regulatory Guide 1.99, Revision 2 [4], as documented in Reference [5].

4. The pressure and temperature limits were calculated in accordance with Reference [1], "Pressure – Temperature Limits Report Methodology for Boiling Water Reactors," April 2007, as documented in Reference [6].

5. This revision of the pressure and temperature limits is to incorporate the following changes:
   - Revision 1: Operation of the RPV under a vacuum.

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

Changes to the curves, limits, or parameters within this PTLR, based upon new surveillance capsule data of the RPV, cannot be made without prior NRC approval. Such analysis and revisions shall be submitted to the NRC for review prior to incorporation into the PTLR.

4.0 Operating Limits

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

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

Complete P-T curves were developed for 54 EFPY for Monticello Nuclear Generating Plant, as documented in Reference [6]. The minimum required leak test temperature (Curve A) at 54 EFPY is above 200°F. Because of the operational challenges presented by this elevated temperature, additional Curve A limits were developed at intermediate levels of 36 and 40 EFPY. Curve B and Curve C limits were not developed at 36 and 40 EFPY because the 54 EFPY limits for these curves do not present an operational challenge to MNGP. The MNGP Curve A limits for 36 EFPY are provided in Figure 1, and a tabulation of the curves is included in Table 1. The MNGP Curve A limits for 40 EFPY are provided in Figure 2, and a tabulation of the curves is included in Table 2. The MNGP P-T curves for 54 EFPY are provided in Figures 3 through 5, and a tabulation of the curves is included in Tables 3 through 5. The adjusted reference temperature (ART) tables for the MNGP vessel beltline materials are shown in Table 6 for 36 EFPY, Table 7 for 40 EFPY, and Table 8 for 54 EFPY (Reference [5]). The resulting P-T curves are based on the geometry, design and materials information for the MNGP vessel. The following conditions apply to operation of the MNGP vessel:

- Heatup and Cooldown rate limit during Hydrostatic Class 1 Leak Testing (Figures 1 through 3: Curve A): ≤ **25°F/hour**[1] [1].
- Normal Operating Heatup and Cooldown rate limit (Figure 4: Curve B – core non-critical, and Figure 5: Curve C – core critical): ≤ **100°F/hour**[2] [6].
- Recirculation loop coolant temperature to RPV coolant temperature ΔT limit during Recirculation Pump startup: ≤ **50°F**.
- RPV bottom head coolant temperature to RPV coolant temperature ΔT limit during Recirculation Pump startup: ≤ **145°F**.
- RPV head flange, RPV flange and adjacent shell temperature limit during vessel bolt-up ≥ **60°F** [6].

5.0 Discussion

The adjusted reference temperature (ART) of the limiting beltline material is used to adjust beltline P-T curves to account for irradiation effects. Regulatory Guide 1.99, Revision 2 (RG 1.99) [4] provides the methods for determining the ART. The RG 1.99 methods for determining the limiting material and adjusting the P-T curves using ART are discussed in this section.

The vessel beltline copper (Cu) and nickel (Ni) values were obtained from the evaluation of the MNGP vessel plate, weld, and forging materials [5]; this evaluation included the results of three surveillance capsules. The Cu and Ni values were used with Table 1 of RG 1.99 to determine a chemistry factor (CF) per Paragraph 1.1 of RG 1.99 for welds. The Cu and Ni values were used with Table 2 of RG 1.99 to determine a CF per Paragraph 1.1 of RG 1.99 for plates and forgings.

[1] Interpreted as the temperature change in any 1-hour period is less than or equal to 25°F.

[2] Interpreted as the temperature change in any 1-hour period is less than or equal to 100°F.

The peak RPV ID fluence value of 6.43 x 10^{18} n/cm^2 at 54 EFPY used in the P-T curve evaluation was obtained from Reference [3] and is calculated in accordance with RG 1.190 [2]. The intermediate peak RPV ID fluence values of 2.77 x 10^{18} n/cm^2 at 36 EFPY and 3.36 x 10^{18} n/cm^2 at 40 EFPY are calculated in [5] based on the flux values in [3]. The flux values in [3] are calculated in accordance with RG 1.190. Calculation details for intermediate fluence values, including benchmarking to the peak RPV ID fluence at 54 EFPY in [3], are given in [5, Appendix A]. These fluence values apply to the limiting beltline lower intermediate shell plates (Heat No. C2220-1 and C2220-2). The fluence values for the lower intermediate shell plates are based upon an attenuation factor of 0.738 for a postulated 1/4T flaw. As a result, the 1/4T fluence for the limiting lower intermediate shell plate is 2.04 x 10^{18} n/cm^2 at 36 EFPY, 2.48 x 10^{18} n/cm^2 at 40 EFPY, and 4.75 x 10^{18} n/cm^2 at 54 EFPY for MNGP.

The RPV ID fluence value of 1.01 x 10^{18} n/cm^2 at 54 EFPY used in the P-T curve evaluation of the recirculation inlet nozzle was obtained from Reference [5] and is calculated in accordance with RG 1.190 [2]. The intermediate RPV ID fluence values of 4.27 x 10^{17} n/cm^2 at 36 EFPY and 5.23 x 10^{17} n/cm^2 at 40 EFPY are calculated in [5] based on the flux values in [3]. The flux values in [3] are calculated in accordance with RG 1.190. Calculation details for intermediate fluence values, including benchmarking to the peak RPV ID fluence at 54 EFPY in [3], are given in [5, Appendix A]. These fluence values apply to the limiting recirculation inlet nozzle (Heat No. E21VW). The fluence value for the recirculation inlet nozzle is based upon an attenuation factor of 0.738 for a postulated 1/4T flaw. As a result, the 1/4T fluence for the limiting recirculation inlet nozzle is 3.151 x 10^{17} n/cm^2 at 36 EFPY, 3.86 x 10^{17} n/cm^2 at 40 EFPY, and 7.45 x 10^{17} n/cm^2 at 54 EFPY for MNGP. There are no additional forged or instrument nozzles in the extended beltline at 54 EFPY.

The P-T curves for the core not critical and core critical operating conditions at a given EFPY apply for both the 1/4T and 3/4T locations. When combining pressure and thermal stresses, it is usually necessary to evaluate stresses at the 1/4T location (inside surface flaw) and the 3/4T

location (outside surface flaw). This is because the thermal gradient tensile stress of interest is in the inner wall during cooldown and is in the outer wall during heatup. However, as a conservative simplification, the thermal gradient stresses at the 1/4T location are assumed to be tensile for both heatup and cooldown. This results in the approach of applying the maximum tensile stresses at the 1/4T location. This approach is conservative because irradiation effects cause the allowable toughness at the 1/4T to be less than that at 3/4T for a given metal temperature. This approach causes no operational difficulties, since the BWR is at steam saturation conditions during normal operation, which is well above the P-T curve limits.

For the core not critical curve (Curve B) and the core critical curve (Curve C), the P-T curves specify a coolant heatup and cooldown temperature rate of ≤ 100°F/hr for which the curves are applicable. However, the core not critical and the core critical curves were also developed to bound RPV thermal transients. For the hydrostatic pressure and leak test curves (Curve A), a coolant heatup and cooldown temperature rate of ≤ 25°F/hr must be maintained. The P-T limits and corresponding limits of either Curve A or B may be applied, if necessary, while achieving or recovering from test conditions. So, although Curve A applies during pressure testing, the limits of Curve B may be conservatively used during pressure testing if the pressure test heatup/cooldown rate limits cannot be maintained.

The initial RT_{NDT}, the chemistry (weight-percent copper and nickel) and ART at the 1/4T location for all RPV beltline materials significantly affected by fluence (i.e., fluence > 10^{17} n/cm^2 for E > 1MeV) are shown in Table 6 for 36 EFPY, Table 7 for 40 EFPY, and Table 8 for 54 EFPY [5].

Per Reference [5] and in accordance with Appendix A of Reference [1], the MNGP representative weld and plate surveillance materials data were reviewed from the Boiling Water Reactor Vessel and Internals Project (BWRVIP) Integrated Surveillance Program (ISP). The representative heat of the plate material (C2220) in the ISP is the same as the lower intermediate

shell plate material in the vessel beltline region of MNGP. For plate heat C2220, since the scatter in the fitted results is less than 1-sigma (17°F), the margin term (σ_Δ = 17°F) is cut in half for the plate material when calculating the ART. The representative heat of the weld material (5P6756) in the ISP is not the same as the limiting weld material in the vessel beltline region of MNGP.

Therefore, CFs from the tables in RG1.99 were used in the determination of the ART values for all MNGP materials except for plate heat C2220.

The only computer code used in the determination of the MNGP P-T curves was the ANSYS Mechanical and PrepPost, Release 11.0 (with Service Pack 1) [7] finite element computer program for the feedwater nozzle (non-beltline) and recirculation inlet nozzle (beltline) stresses. The ANSYS program was controlled under the vendor's 10 CFR 50 Appendix B [8] Quality Assurance Program for nuclear quality-related work. Benchmarking consistent with NRC GL 83-11, Supplement 1 [9] was performed as a part of the computer program verification by comparing the solutions produced by the computer code to hand calculations for several problems.

The plant-specific MNGP feedwater nozzle analysis was performed to determine through-wall thermal and pressure stress distributions due to a bounding thermal transient [10]. Detailed information regarding the analysis can be found in Reference [10]. The following inputs were used as input to the finite element analysis:

- With respect to operating conditions, stress distributions were developed for two bounding thermal transients. A thermal shock, which represents the maximum thermal shock for the feedwater nozzle during normal operating conditions, and a thermal ramp were analyzed [10]. Because the feedwater nozzle thermal sleeve is an integral part of the safe-end, the thermal shock that occurs in the feedwater nozzle as part of the startup transient is significantly reduced. As a result, the thermal ramp of 100°F/hr, which is

associated with the shutdown transient, produces higher tensile stresses at the 1/4T location. Therefore, the stresses represent the bounding stresses in the feedwater nozzle associated with 100°F/hr heatup/cooldown limits associated with the P-T curves for the upper vessel feedwater nozzle region.

- Heat transfer coefficients were given in the MNGP feedwater nozzle governing basis stress report for both forced and free convection in the vessel. The analysis used the higher forced convection coefficient of 500 Btu/hr-ft^2-°F, and applied it to all wetted surfaces [10]. Therefore, the heat transfer coefficients used in the analysis bound the actual operating conditions in the feedwater nozzle at MNGP.
- A one-quarter symmetric, three-dimensional finite element model of the feedwater nozzle was constructed (Reference 10). Temperature dependent material properties, taken from the MNGP Code of Record [11], were used in the evaluation.

The plant-specific MNGP recirculation inlet nozzle analysis was performed to determine through-wall thermal and pressure stress distributions due to a bounding thermal transient [12]. Detailed information regarding the analysis can be found in Reference [12]. The following inputs were used as input to the finite element analysis:

- With respect to operating conditions, the thermal transient that would produce the highest tensile stresses at the 1/4T location is the 100°F/hr shutdown transient [12]. Therefore, the stresses represent the bounding stresses in the recirculation inlet nozzle associated with 100°F/hr heatup/cooldown limits associated with the P-T curves for a nozzle in the beltline region.
- Heat transfer coefficients were calculated in accordance with the MNGP recirculation inlet nozzle governing basis stress report. The heat transfer coefficients were conservatively based on the full temperature difference of the transient, rather than the RPV to coolant temperature difference [12]. The nozzle blend radius heat transfer

coefficient used the higher of the calculated vessel heat transfer coefficient (675 Btu/hr-ft^2-°F) or the calculated nozzle heat transfer coefficient (265 Btu/hr-ft^2-°F). Therefore, the heat transfer coefficients used in the analysis bound the actual operating conditions in the recirculation inlet nozzle at MNGP.

- A one-quarter symmetric, three-dimensional finite element model of the recirculation inlet nozzle was constructed (Reference 12). Temperature dependent material properties, taken from the MNGP Code of Record [11], were used in the evaluation.

Reference [13] contains NRC approval of Monticello initial RTNDT values which are used in development of the Pressure-Temperature limits documented in this PTLR.

6.0 Plant-Specific Information

EPU vs. MELLLA+ Fluence Calculations

MNGP is planning to implement both an extended power uprate (EPU) to 2004 MWth and MELLLA+ (Maximum Extended Load Line Limit Analysis) operation during the current operating license. In preparation for these changes, fluence calculations were performed in accordance with Reg Guide 1.190 to determine the effects on the flux profile of the reactor vessel and its internals. In 2007, a fluence calculation was developed to determine the projected fluence accumulation for the reactor vessel considering EPU power level (2004 MWTH) to the end of the current operating license (54 EFPY/2030). In 2009, an additional fluence calculation was performed to consider EPU power levels with MELLLA+ operation to the end of the current operating license at 2004 MWth. Since both calculations were developed in accordance with Reg Guide 1.190, the fluence values for components used to determine adjusted reference temperature and related pressure-temperature limits and curves were compared in the fluence calculations and the most conservative value was used. For all components, the 2007 EPU-only fluence calculation was more conservative than the EPU/MELLLA+ values and the EPU-only values were used in the determination of the pressure-temperature limits and curves in the PTLR.

Excess Conservatism in Fluence and Multiple Curves for Hydrostatic Pressure Test

While reviewing the EPU-only fluence calculation, it was determined that fluence values for locations with an accumulated fluence nearer to the lower bound of 1.0 x 10^{17} n/cm^2 were overly conservative. The fluence values for these locations were given an additional factor of 1.3 to account for potential variation in future operation and assumed EPU was implemented after Cycle 22 in 2005 (28.82 EFPY). The overly conservative fluence values resulted in hydrostatic pressure test temperatures near 212°F. With pressure test temperatures near 212°F, additional preparations must be made in case of entry into Mode 3 during the pressure test. These additional preparations will result in longer outage durations, additional dose and more risk to the site and site personnel.

In order to avoid entry in Mode 3, some of the conservatism was removed from the fluence values for the upper intermediate shell plates, lower shell plates and the N-2 Nozzles. The conservatism was removed by applying the 1.3 factor only to operation past EPU (33.4 EFPY) for fluence calculated at 36 EFPY and 40 EFPY. Even with the excess conservatism removed, the fluence values are conservative because a review of past operation and fluence accumulation on the reactor vessel show that conditions before 33.4 EFPY (2011) are bounded by pre-EPU fluence without the 1.3 factor. 33.4 EFPY is determined to be the EFPY as of April 2011 and for the purposes of this evaluation and to maintain margin and conservatism it is assumed to be the beginning of EPU implementation. The flux values used to calculate the fluence values with the excess conservatism removed were calculated in accordance with NRC Reg Guide 1.190. The fluence values with the removed excess conservatism were calculated at 36, 40 and 54 EFPY are shown in the following table.

RPV Component	Component Fluence[5]		
	36 EFPY	40 EFPY	54 EFPY
	n/cm²	*n/cm²*	*n/cm²*
Upper Intermediate Shell Plates (I-12 and I-13)	1.97×10^{17}	2.30×10^{17}	4.06×10^{17}
Lower Intermediate Shell Plates (I-14 and I-15)	2.77×10^{18}	3.36×10^{18}	6.43×10^{18}
Lower Shell Plates (I-16 and I-17)	1.85×10^{18}	2.28×10^{18}	4.46×10^{18}
Limiting Weld	2.77×10^{18}	3.36×10^{18}	6.43×10^{18}
N-2 Nozzles	4.27×10^{17}	5.23×10^{17}	1.01×10^{18}

Each of the various curves will be used for the hydrostatic pressure-test required at the end of each refueling outage. The curve that will be used for a specific outage will be determined by the accumulated fluence on the vessel. The hydrostatic test procedure will include a step to verify the vessel accumulation and determine which curve will bound the current vessel fluence accumulation for use in that specific outage.

Monticello 300° Surveillance Capsule

In 2007, Monticello sent the surveillance capsule located at the 300° reactor vessel azimuth out for testing in accordance with the requirements of the BWRVIP Integrated Surveillance Program (ISP) of which Monticello is an active member. The results of the testing were received in March 2009 and in accordance with the requirement of the ISP and Reg Guide 1.190, these results must be included in fluence calculations for the development of any pressure-temperature limits including the PTLR. Since the fluence calculation used for developing the pressure-temperature limits was completed in 2007, the surveillance capsule results were not included in the fluence evaluation. In order to incorporate the 2009 surveillance capsule data, the results were evaluated by General Electric to determine if the fluence accumulated by the surveillance capsule was

within the uncertainty range of the fluence calculation performed in 2007. GE found that the fluence capsule data was within the uncertainty range of the fluence calculation from 2007. [15]

Operation of the RPV Under a Vacuum

In April 2014, it was discovered that the RPV is operated under a vacuum during startup operations. Drawing a vacuum on the RPV was evaluated and it was determined that the RPV remains acceptable at all conditions including a slight vacuum caused by the pre-start up evolution.

During startup, operations closes the RPV Head Vent lines, opens the Main Steam Isolation Valves (MSIVs) to the condenser and places the Mechanical Vacuum Pump (MVP) in service. This configuration allows a slight vacuum to be drawn on the upper portion of the vessel. The straight line on the hydrostatic (Curve A), core not critical (Curve B), and core critical (Curve C) curves terminates at 0 psig. The straight line on Curves A, B and C is representative of the 10CFR50 Appendix G minimum required temperature for the RPV in low pressure conditions. The PTLR curves have traditionally started at 0 psig for simplification of the curve illustration and based on pressure sensor equipment limitations. However, 10CFR50 Appendix G has no lower pressure limitation related to the minimum required temperature. The 10CFR50 Appendix G requirement for low vessel pressures is to maintain the minimum metal temperature during both normal operation and hydrostatic pressure and leak tests. This requirement also includes vessel pressures below 0 psig. Based on the discovery, a note was added to Curves A, B and C to indicate that the P-T limit at 0 psig is applicable for RPV operation under vacuum as long as the minimum required vessel temperature is maintained in accordance with 10CFR50 Appendix G.

7.0 References

1. 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.
2. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence", March 2001.
3. MNGP Site Calculation 11-039, "Monticello Neutron Flux and Fluence Evaluation for Extended Power Uprate," December 2007
4. U. S. Nuclear Regulatory Commission, Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel materials," May 1988.
5. Structural Integrity Associates Calculation No. 1000847.301, Revision 2, "Evaluation of Adjusted Reference Temperatures and Reference Temperature Shifts," July 2011. (MNGP Site Calculation 11-003, Rev. 0A)
6. Structural Integrity Associates Calculation No. 1000847.303, Revision 2, "Revised P-T Curves Calculation," August 2011. (MNGP Site Calculation 11-005, Rev. 0A)
7. ANSYS Mechanical and PrepPost, Release 11.0 (w/Service Pack 1), ANSYS, Inc., August 2007.
8. U. S. Code of Federal Regulations, Title 10, Energy, Part 50, Appendix B, "Quality Assurance for Nuclear Power Plants and Fuel Reprocessing Plants".
9. U. S. Nuclear Regulatory Commission, Generic Letter 83-11, Supplement 1, "License Qualification for Performing Safety Analyses," June 24, 1999.
10. Structural Integrity Associates Calculation No. 1000847.302, Revision 0, "Finite Element Stress Analysis of Monticello RPV Feedwater Nozzle," October 2010. (MNGP Site Calculation 11-004, Rev. 0)

11. ASME Boiler and Pressure Vessel Code, Section III including Appendices, 1977 Edition with Addenda through Summer 1978.

12. Structural Integrity Associates Calculation No. 1000720.301, Revision 0, "Finite Element Stress Analysis of Monticello RPV Recirculation Inlet Nozzle," June 2010. (MNGP Calculation 11-020, Rev. 0)

13. NRC (C.F. Lyon) letter to NMC (R.O Anderson), "Monticello Nuclear Generating Plant-Issuance of Amendment RE: Revision of Reactor Vessel Pressure-Temperature Limit Curves and Removal of Standby Liquid Control Relief Valve Setpoint (TAC No. MA4532)", dated October 12, 1999.

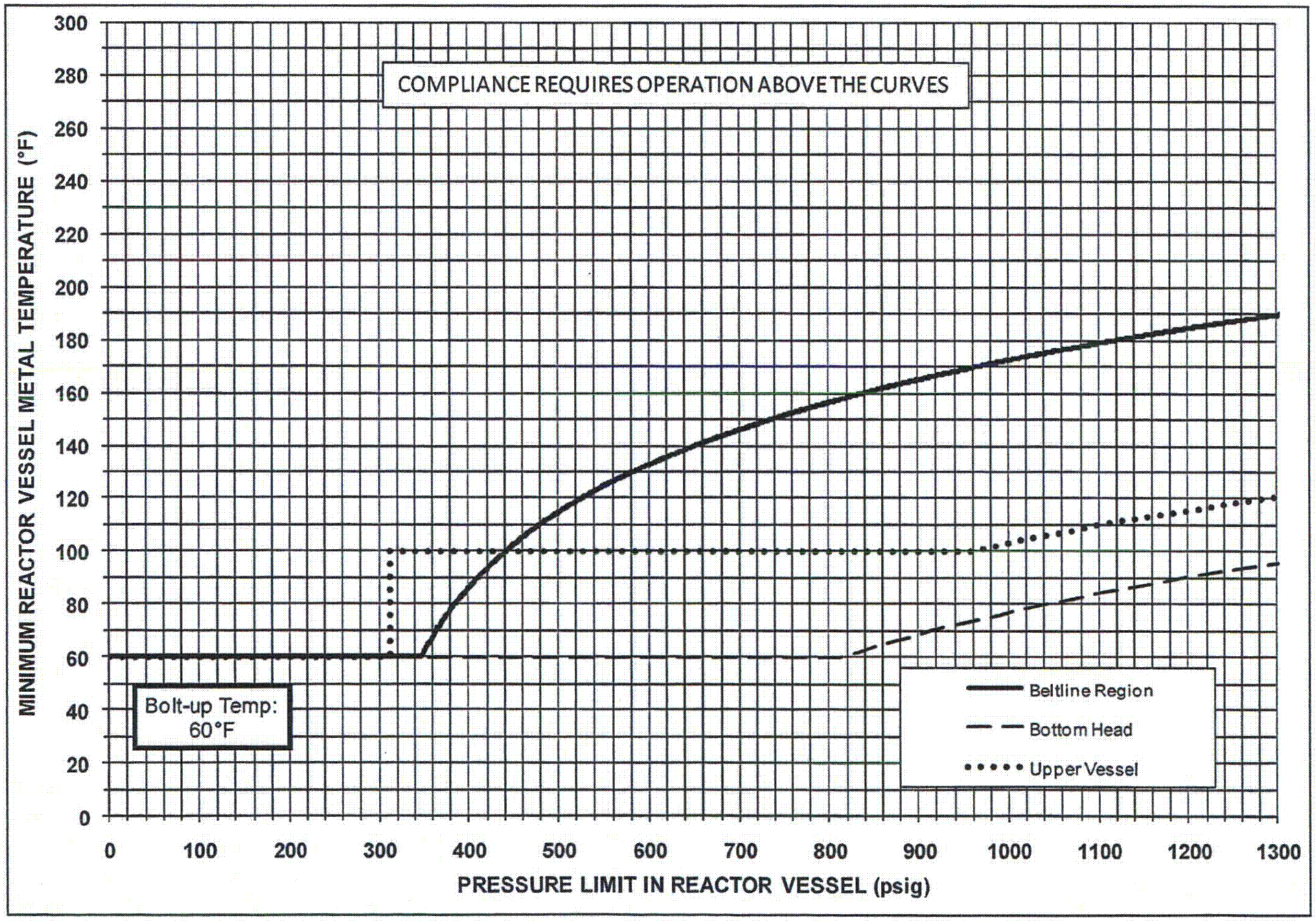
14. NRC (L. M. Padovan) letter to NMC (D. L. Wilson), "Monticello Nuclear Generating Plant – Issuance of Amendment re: Boiling Water Reactor Vessel and Internals Project Reactor Pressure Vessel Integrated Surveillance Program (TAC No. MB6460)", dated April 22, 2003.

15. G.E Letter Number 0000-0122-7030, Revision 0, "Calculation-to-Measurement Ratio of Monticello 300-Degree Surveillance Capsule", August 2010, **CONTAINS PROPRIETARY INFORMATION**

16. EC 23962, Revision 0, "Structural Integrity of the Reactor Vessel (RPV) under a Vacuum", April 2014

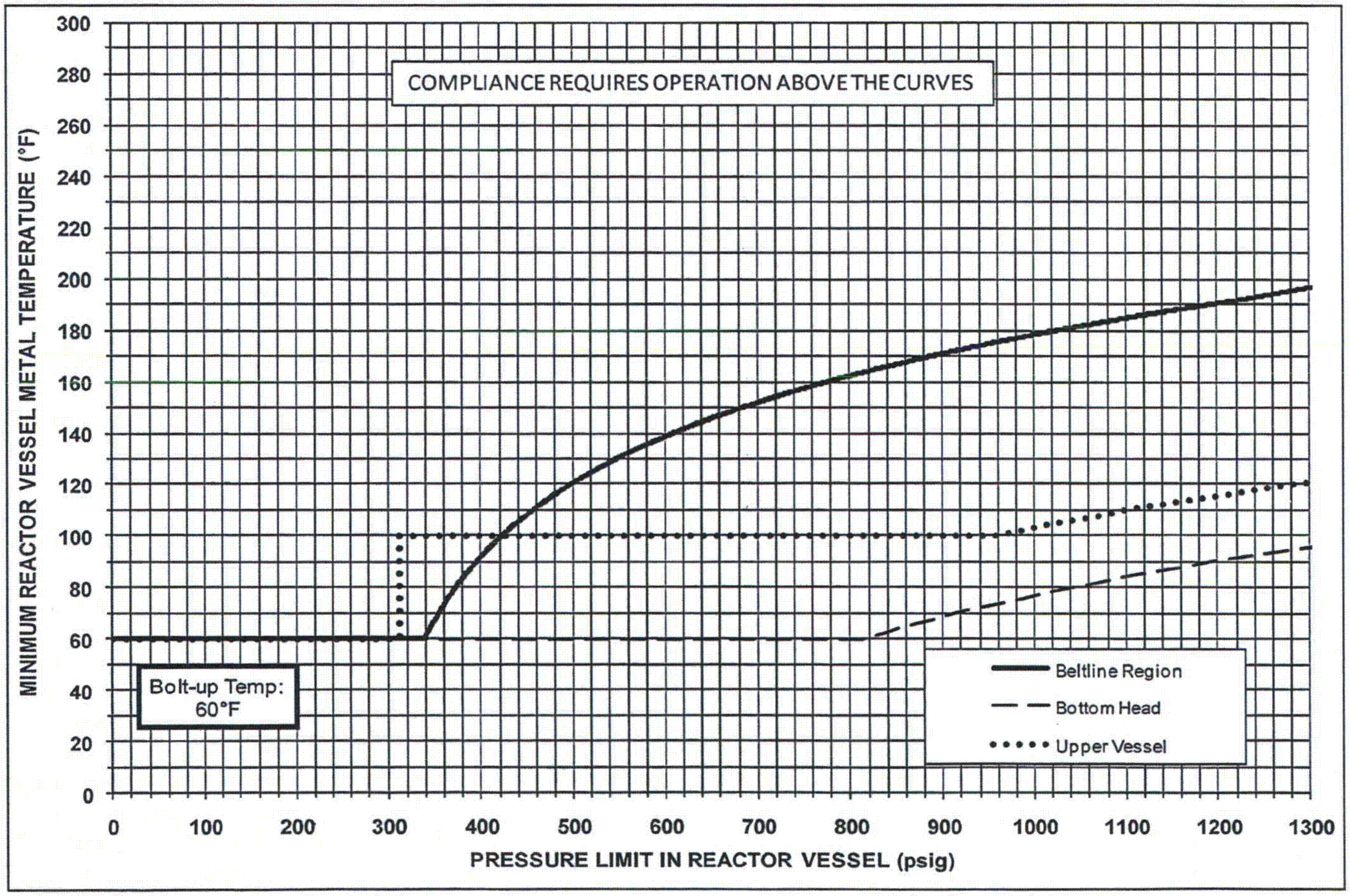
17. EC 23963, Revision 0, "Monticello P-T Curve Limit Violation Assessment Vendor-Prepared", April 2014

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



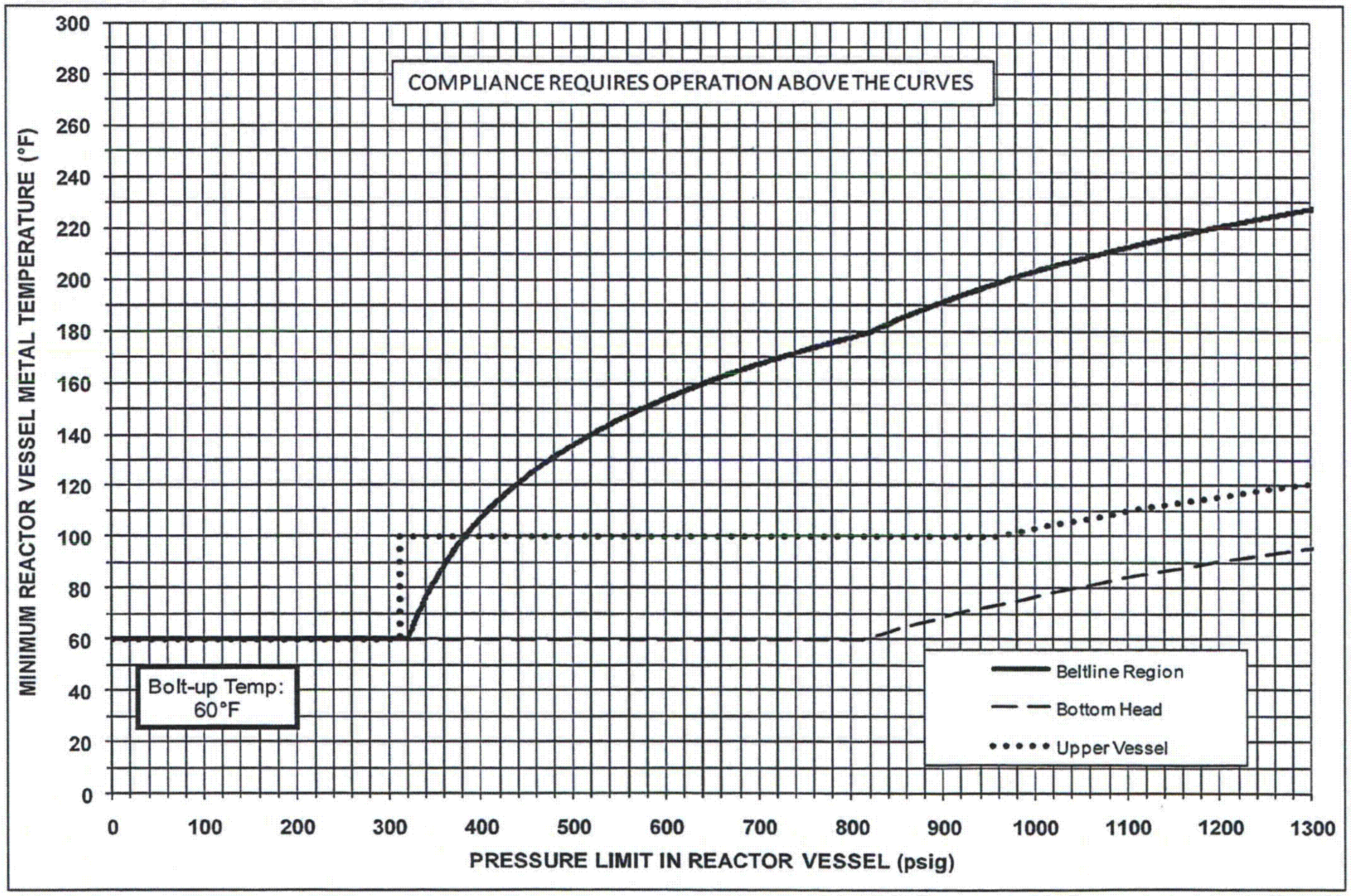
Note: The minimum reactor vessel metal temperature at 0 psig is applicable for RPV operation under a vacuum.

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



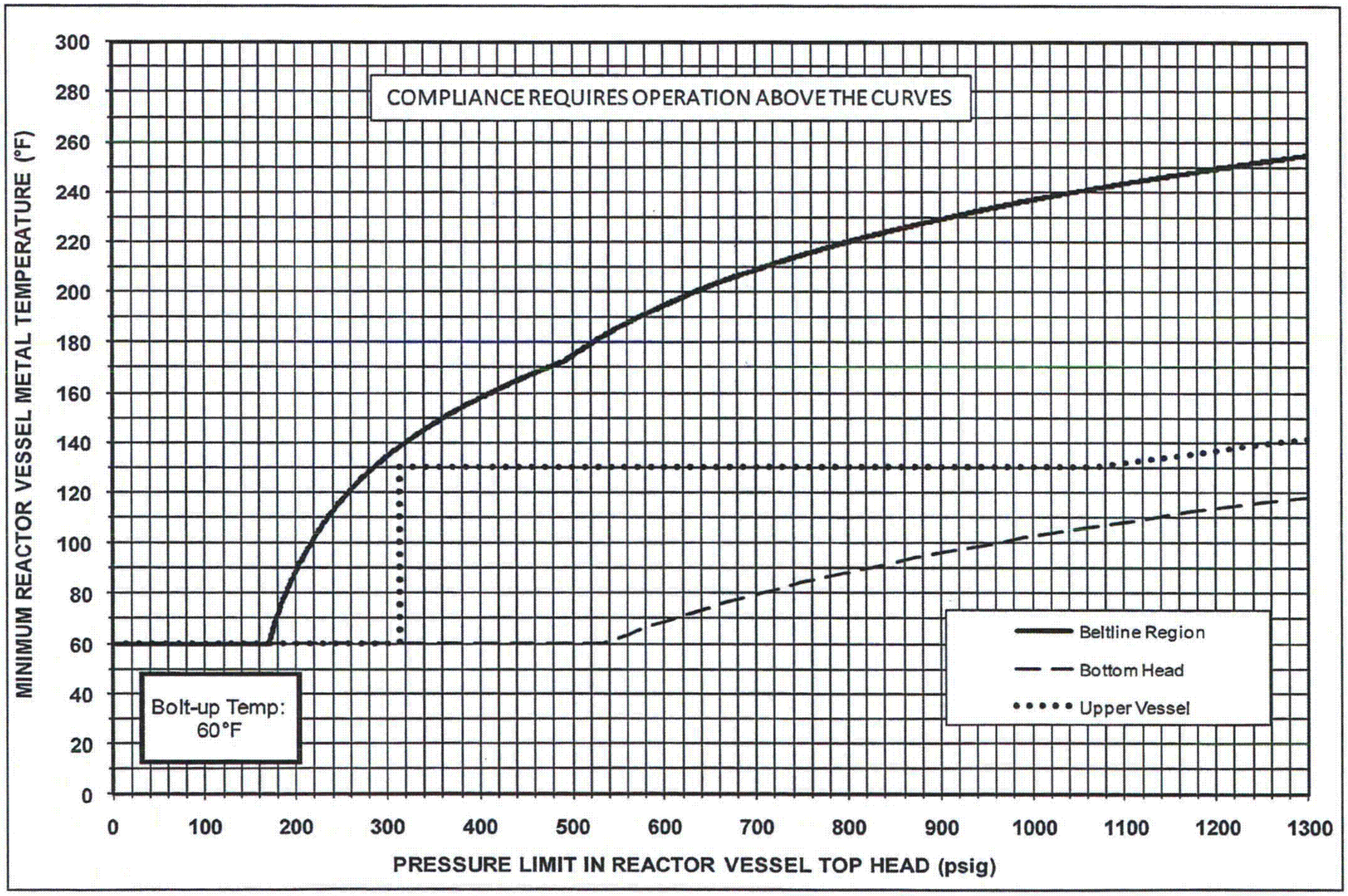
Note: The minimum reactor vessel metal temperature at 0 psig is applicable for RPV operation under a vacuum.

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



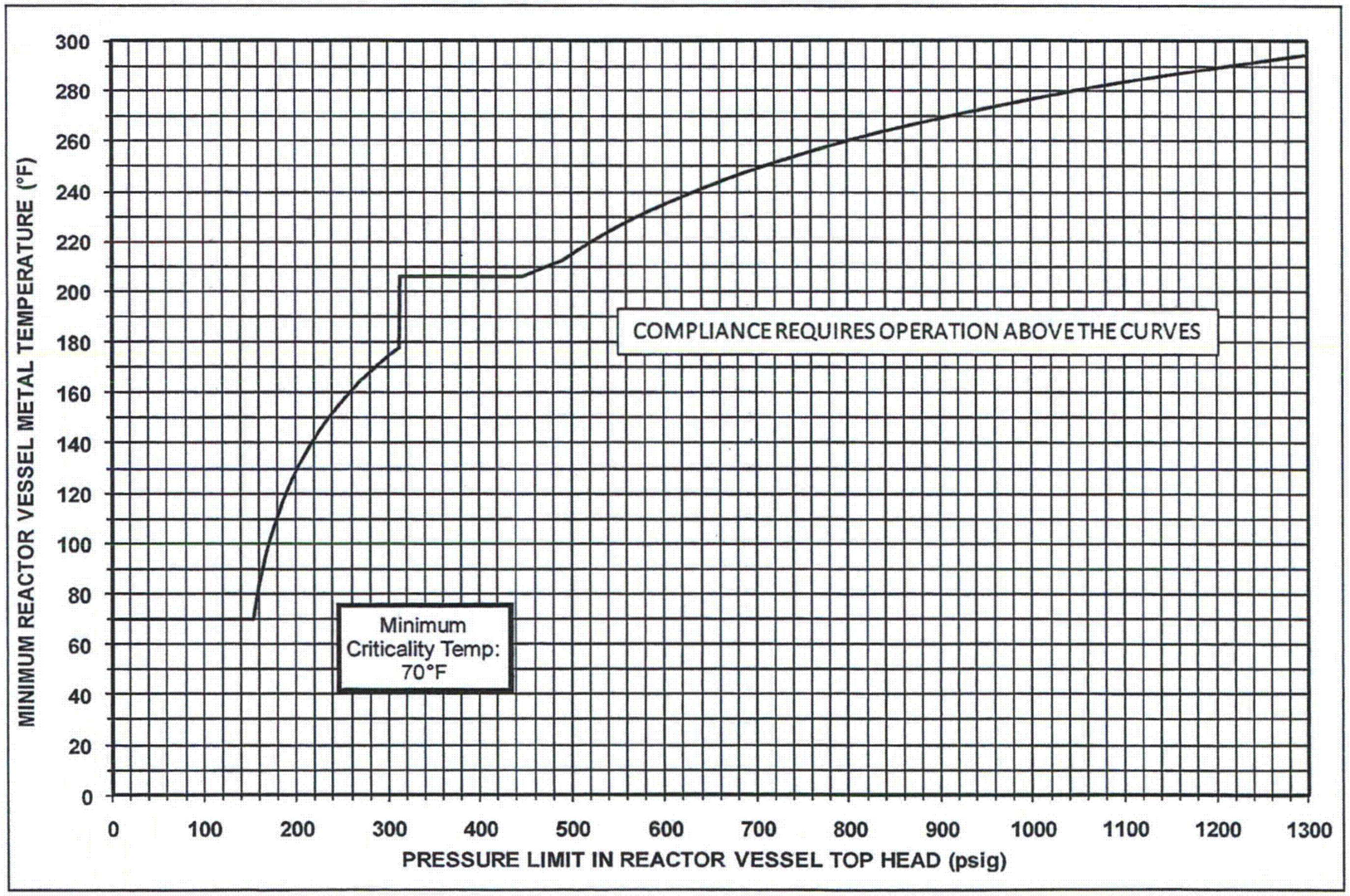
Note: The minimum reactor vessel metal temperature at 0 psig is applicable for RPV operation under a vacuum.

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



Note: The minimum reactor vessel metal temperature at 0 psig is applicable for RPV operation under a vacuum.

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



Note: The minimum reactor vessel metal temperature at 0 psig is applicable for RPV operation under a vacuum.

Table 1: MNGP Pressure Test (Curve A) P-T Curves for 36 EFPY

Beltline Region

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 1: MNGP Pressure Test (Curve A) P-T Curves for 36 EFPY (continued)

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
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 1: MNGP Pressure Test (Curve A) P-T Curves for 36 EFPY (continued)

Plant =	MNGP	
Component =	Upper Vessel	
ART =	40.0	°F
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 2: MNGP Pressure Test (Curve A) P-T Curves for 40 EFPY

Beltline Region

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 2: MNGP Pressure Test (Curve A) P-T Curves for 40 EFPY (continued)

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
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 2: MNGP Pressure Test (Curve A) P-T Curves for 40 EFPY (continued)

Plant =	MNGP	
Component =	Upper Vessel	
ART =	40.0	°F
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 3: MNGP Pressure Test (Curve A) P-T Curves for 54 EFPY

Beltline Region

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 3: MNGP Pressure Test (Curve A) P-T Curves for 54 EFPY (continued)

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
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 3: MNGP Pressure Test (Curve A) P-T Curves for 54 EFPY (continued)

Plant =	MNGP	
Component =	Upper Vessel	
ART =	40.0	°F
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 4: MNGP Core Not Critical (Curve B) P-T Curves for 54 EFPY

Beltline Region

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 4: MNGP Core Not Critical (Curve B) P-T Curves for 54 EFPY (continued)

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
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 4: MNGP Core Not Critical (Curve B) P-T Curves for 54 EFPY (continued)

Plant =	MNGP	
Component =	Upper Vessel	
ART =	40.0	°F
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 5: MNGP Core Critical (Curve C) P-T Curves 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

Table 6: MNGP ART Calculations for 36 EFPY

Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms		ART_{NDT} (°F)
									σ_Δ (°F)	σ_i (°F)	
Upper/Int Shell I-12	-	C2089-1	-	0.0	0.35	0.50	199.50	28.0	14.0	0.0	56.1
Upper/Int Shell I-13	-	C2613-1	-	27.0	0.35	0.49	198.25	27.9	13.9	0.0	82.7
Lower/Int Shell I-14	**-**	**C2220-1**	**-**	**27.0**	**0.16**	**0.64**	**180.00**	**103.4**	**8.5**	**0.0**	**147.4**
Lower/Int Shell I-15	**-**	**C2220-2**	**-**	**27.0**	**0.16**	**0.64**	**180.00**	**103.4**	**8.5**	**0.0**	**147.4**
Lower Shell I-16	-	A0946-1	-	27.0	0.14	0.56	98.20	47.3	17.0	0.0	108.3
Lower Shell I-17	-	C2193-1	-	0.0	0.17	0.50	118.50	57.1	17.0	0.0	91.1

Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms		ART_{NDT} (°F)
									σ_Δ (°F)	σ_i (°F)	
Limiting Weld - Beltline	**-**	**-**	**E8018N**	**-65.6**	**0.10**	**0.99**	**134.90**	**77.5**	**28.0**	**12.7**	**73.4**

Description	Code No.	Heat No.	Plate Location	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms		ART_{NDT} (°F)
									σ_Δ (°F)	σ_i (°F)	
Bounding N-2 Nozzle	**-**	**E21VW**	**Plate I-16 / I-17**	**40.0**	**0.18**	**0.86**	**141.90**	**32.1**	**16.0**	**0.0**	**104.1**

Fluence Data

Location	Wall Thickness (in)		Fluence at ID (n/cm^2)	Attenuation, 1/4t $e^{-0.24x}$	Fluence at 1/4t (n/cm^2)	Fluence Factor, FF $f^{(0.28 - 0.10 \log f)}$
	Full	1/4t				
Upper/Int Shell I-12	5.063	1.266	1.97E+17	0.738	1.454E+17	0.141
Upper/Int Shell I-13	5.063	1.266	1.97E+17	0.738	1.454E+17	0.141
Lower/Int Shell I-14	5.063	1.266	2.77E+18	0.738	2.044E+18	0.575
Lower/Int Shell I-15	5.063	1.266	2.77E+18	0.738	2.044E+18	0.575
Lower Shell I-16	5.063	1.266	1.85E+18	0.738	1.365E+18	0.482
Lower Shell I-17	5.063	1.266	1.85E+18	0.738	1.365E+18	0.482
Limiting Weld - Beltline	5.063	1.266	2.77E+18	0.738	2.044E+18	0.575
Bounding N-2 Nozzle	5.063	1.266	4.27E+17	0.738	3.151E+17	0.226

Table 7: MNGP ART Calculations for 40 EFPY

Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms σ_Δ (°F)	Margin Terms σ_i (°F)	ART_{NDT} (°F)
Upper/Int Shell I-12	-	C2089-1	-	0.0	0.35	0.50	199.50	31.0	15.5	0.0	61.9
Upper/Int Shell I-13	-	C2613-1	-	27.0	0.35	0.49	198.25	30.8	15.4	0.0	88.6
Lower/Int Shell I-14	**-**	**C2220-1**	**-**	**27.0**	**0.16**	**0.64**	**180.00**	**112.0**	**8.5**	**0.0**	**156.0**
Lower/Int Shell I-15	**-**	**C2220-2**	**-**	**27.0**	**0.16**	**0.64**	**180.00**	**112.0**	**8.5**	**0.0**	**156.0**
Lower Shell I-16	-	A0946-1	-	27.0	0.14	0.56	98.20	51.9	17.0	0.0	112.9
Lower Shell I-17	-	C2193-1	-	0.0	0.17	0.50	118.50	62.7	17.0	0.0	96.7

Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms σ_Δ (°F)	Margin Terms σ_i (°F)	ART_{NDT} (°F)
Limiting Weld - Beltline	**-**	**-**	**E8018N**	**-65.6**	**0.10**	**0.99**	**134.90**	**83.9**	**28.0**	**12.7**	**79.8**

Description	Code No.	Heat No.	Plate Location	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms σ_Δ (°F)	Margin Terms σ_i (°F)	ART_{NDT} (°F)
Bounding N-2 Nozzle	**-**	**E21VW**	**Plate I-16 / I-17**	**40.0**	**0.18**	**0.86**	**141.90**	**36.0**	**17.0**	**0.0**	**110.0**

Fluence Data

Location	Wall Thickness (in) Full	Wall Thickness (in) 1/4t	Fluence at ID (n/cm^2)	Attenuation, 1/4t $e^{-0.24x}$	Fluence at 1/4t (n/cm^2)	Fluence Factor, FF $f^{(0.28 - 0.10 \log f)}$
Upper/Int Shell I-12	5.063	1.266	2.30E+17	0.738	1.698E+17	0.155
Upper/Int Shell I-13	5.063	1.266	2.30E+17	0.738	1.698E+17	0.155
Lower/Int Shell I-14	5.063	1.266	3.36E+18	0.738	2.48E+18	0.622
Lower/Int Shell I-15	5.063	1.266	3.36E+18	0.738	2.48E+18	0.622
Lower Shell I-16	5.063	1.266	2.28E+18	0.738	1.683E+18	0.529
Lower Shell I-17	5.063	1.266	2.28E+18	0.738	1.683E+18	0.529
Limiting Weld - Beltline	5.063	1.266	3.36E+18	0.738	2.48E+18	0.622
Bounding N-2 Nozzle	5.063	1.266	5.23E+17	0.738	3.86E+17	0.254

Table 8: MNGP ART Calculations for 54 EFPY

Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms		ART_{NDT} (°F)
									σ_Δ (°F)	σ_i (°F)	
Upper/Int Shell I-12	-	C2089-1	-	0.0	0.35	0.50	199.50	43.8	17.0	0.0	77.8
Upper/Int Shell I-13	-	C2613-1	-	27.0	0.35	0.49	198.25	43.5	17.0	0.0	104.5
Lower/Int Shell I-14	**-**	**C2220-1**	**-**	**27.0**	**0.16**	**0.64**	**180.00**	**142.6**	**8.5**	**0.0**	**186.6**
Lower/Int Shell I-15	**-**	**C2220-2**	**-**	**27.0**	**0.16**	**0.64**	**180.00**	**142.6**	**8.5**	**0.0**	**186.6**
Lower Shell I-16	-	A0946-1	-	27.0	0.14	0.56	98.20	68.2	17.0	0.0	129.2
Lower Shell I-17	-	C2193-1	-	0.0	0.17	0.50	118.50	82.3	17.0	0.0	116.3

Description	Code No.	Heat No.	Flux Type & Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms		ART_{NDT} (°F)
									σ_Δ (°F)	σ_i (°F)	
Limiting Weld - Beltline	**-**	**-**	**E8018N**	**-65.6**	**0.10**	**0.99**	**134.90**	**106.9**	**28.0**	**12.7**	**102.8**

Description	Code No.	Heat No.	Plate Location	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments For 1/4t			
					Cu (wt %)	Ni (wt %)		ΔRT_{NDT} (°F)	Margin Terms		ART_{NDT} (°F)
									σ_Δ (°F)	σ_i (°F)	
Bounding N-2 Nozzle	**-**	**E21VW**	**Plate I-16 / I-17**	**40.0**	**0.18**	**0.86**	**141.90**	**51.2**	**17.0**	**0.0**	**125.2**

Fluence Data

Location	Wall Thickness (in)		Fluence at ID	Attenuation, 1/4t	Fluence at 1/4t	Fluence Factor, FF
	Full	1/4t	(n/cm^2)	$e^{-0.24x}$	(n/cm^2)	$f^{(0.28 - 0.10 \log f)}$
Upper/Int Shell I-12	5.063	1.266	4.06E+17	0.738	2.996E+17	0.219
Upper/Int Shell I-13	5.063	1.266	4.06E+17	0.738	2.996E+17	0.219
Lower/Int Shell I-14	5.063	1.266	6.43E+18	0.738	4.746E+18	0.792
Lower/Int Shell I-15	5.063	1.266	6.43E+18	0.738	4.746E+18	0.792
Lower Shell I-16	5.063	1.266	4.46E+18	0.738	3.292E+18	0.694
Lower Shell I-17	5.063	1.266	4.46E+18	0.738	3.292E+18	0.694
Limiting Weld - Beltline	5.063	1.266	6.43E+18	0.738	4.746E+18	0.792
Bounding N-2 Nozzle	5.063	1.266	1.01E+18	0.738	7.454E+17	0.361

Appendix A

MONTICELLO REACTOR VESSEL MATERIALS SURVEILLANCE PROGRAM

In accordance with 10 CFR 50, Appendix H, Reactor Vessel Material Surveillance Program Requirements, a surveillance capsule was removed from the Monticello reactor vessel in 2007. The surveillance capsules contained flux wires for neutron fluence measurement, Charpy V-Notch impact test specimens and uniaxial tensile test specimens fabricated using materials from the vessel materials within the core beltline region.

MNGP has made a licensing commitment to replace the existing surveillance program with the BWRVIP ISP, and intends to use the ISP for MNGP during the period of extended operation. The BWRVIP ISP meets the requirements of 10 CFR 50, Appendix H, for Integrated Surveillance Programs, and has been approved by NRC. Xcel Energy committed to use the ISP in place of its existing surveillance programs in the amendments issued by the NRC regarding the implementation of the Boiling Water Reactor Vessel and Internals Project Reactor Pressure Vessel Integrated Surveillance Program, dated April 22, 2003 [14]. The surveillance capsule removed in 2007 contained flux wires for neutron fluence measurement, Charpy V-Notch impact test specimens and uniaxial tensile test specimens fabricated using materials from the vessel materials within the core beltline region. MNGP continues to be a host plant under the ISP. One more Monticello capsule is scheduled to be removed and tested under the ISP in approximately 2022.

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