ATTACHMENT 3

NINE MILE POINT UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

Nine Mile Point Nuclear Station, LLC
March 3, 2009

Constellation Energy
Nine Mile Point Nuclear Station

NINE MILE POINT NUCLEAR STATION

NINE MILE POINT UNIT 1

Pressure and Temperature Limits Report (PTLR)

PTLR-1, Revision 0

Prepared by: _____ **Date:** 2/13/2009
G. B. Inch
Mechanical Design Engineering

Reviewed by: _____ **Date:** 2/13/2009
R. Conieri
Mechanical Design Engineering

Approved by: _____ **Date:** 2/18/2009
P. E. Bartolini, Supervisor
Mech./Struc. Design Engineering

Approved by: _____ **Date:** 2/17/09
A. D. Sterio, General Supervisor
Design Engineering

This Controlled Document provides reactor pressure vessel pressure and temperature limits for use in conjunction with the Nine Mile Point Unit 1 Technical Specifications. Document pages may only be changed through the re-issue of a revision to the entire document.

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1.0 PURPOSE

The purpose of the Nine Mile Point Nuclear Station Unit 1 (NMP1) 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) head flange bolt-up temperature limits.

This report has been prepared in accordance with the requirements of Technical Specification (TS) Section 6.6.7, "Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR)," and the template provided in Licensing Topical Report SIR-05-044, Revision 0 (Reference 6.1).

2.0 APPLICABILITY

This report is applicable to the NMP1 RPV for 28, 36 and 46 Effective Full-Power Years (EFPY). The following TS sections are affected by the information contained in this report:

- Limiting Condition for Operation Section 3.2.1, "Reactor Vessel Heatup and Cooldown Rates."
- Limiting Condition for Operation Section 3.2.2, "Minimum Reactor Vessel Temperature for Pressurization."
- Surveillance Requirement Section 4.2.2, "Minimum Reactor Vessel Temperature for Pressurization."

3.0 METHODOLOGY

The limits in this report were derived as follows:

(1) The methodology used to calculate the pressure and temperature limits is in accordance with Reference 6.1, which has been approved for BWR use by the NRC. The pressure and temperature limit calculations are documented in Reference 6.2.

(2) The neutron fluence is calculated in accordance with NRC Regulatory Guide (RG) 1.190 (Reference 6.3) based on the wetted surface fluence that is documented in Reference 6.4. The methodology used to calculate the RPV neutron fluence has been approved by the NRC in Reference 6.5.

(3) The adjusted reference temperature (ART) values for the limiting beltline materials are calculated in accordance with NRC Regulatory Guide 1.99, Revision 2 (Reference 6.6), as documented in Reference 6.7.

(4) This revision of the pressure and temperature limits is to incorporate the following changes:

- Initial issue of PTLR.

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, in accordance with TS Section 6.6.7.

4.0 OPERATING LIMITS

The pressure-temperature (P-T) limit curves included in this report represent steam dome pressure versus minimum vessel coolant 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 (heatup and cooldown), referred to as Curve B; and (c) core critical operation (heatup and cooldown), referred to as Curve C.

Complete P-T limit curves were developed for 28, 36 and 46 EFPY for NMP1, as documented in Reference 6.2. The NMP1 P-T limit curves for 28 EFPY are provided in Figures 1 through 3, and a tabulation of the curves is included in Tables 1 through 3. The NMP1 P-T limit curves for 36 EFPY are provided in Figures 4 through 6, and a tabulation of the curves is included in Tables 4 through 6. The NMP1 P-T limit curves for 46 EFPY are provided in Figures 7 through 9, and a tabulation of the curves in included in Tables 7 through 9.

Other conditions applicable to the NMP1 RPV are:

- Heatup and Cooldown rate limit during Hydrostatic and Class 1 Leak Testing (Figures 1, 4 and 7: Curve A): **≤ 25°F/hour**[1].
- Normal Operating Heatup and Cooldown rate limit (Figures 2, 5 and 8: Curve B – non-nuclear heating, and Figures 3, 6 and 9: Curve C – nuclear heating): **≤ 100°F/hour**[2].
- RPV head installation temperature limit (Figures 1, 4 and 7: Curve A – Hydrostatic and Class 1 Leak Testing; Figures 2, 5 and 8: Curve B – non-nuclear heating): **≥ 70°F**[3].
- RPV flange and adjacent shell temperature limit: **≥ 70°F**.

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 (Reference 6.6) 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 NMP1 vessel plate and weld materials (Reference 6.7). The Cu and Ni values were used with Tables 1 and 2 of RG 1.99 to determine a chemistry factor (CF) per Paragraph 1.1 of RG 1.99 for welds and plates, respectively.

The peak RPV inside diameter (ID) fluence values of 1.12×10^{18} n/cm^2 at 28 EFPY and 1.61×10^{18} n/cm^2 at 46 EFPY used in the P-T curve evaluation were obtained from Reference 6.4. Neutron fluence values were calculated using methods that conform to the guidelines of RG 1.190 (Reference 6.3). At 36 EFPY, the peak fluence value of 1.34×10^{18} n/cm^2 was obtained by performing a linear interpolation between the fluence values at 28 and 46 EFPY. These fluence values apply to the limiting beltline lower shell plate (Heat No. P2112 for NMP1). The fluence values for the lower shell plates are based upon an attenuation factor of 0.652 for a

[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.

[3] A higher minimum bolt-up temperature of 70°F was applied to these curves, as compared to the 60°F value determined in Reference 6.2, in order to be consistent with the minimum bolt-up temperature value used in previous studies.

postulated 1/4T flaw. As a result, the 1/4T fluences for 28, 36 and 46 EFPY for the limiting lower shell plate are 7.29×10^{17}, 8.71×10^{17} and 1.05×10^{18} n/cm^2, respectively, for NMP1.

The P-T limit 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 location to be less than that at the 3/4T location for a given metal temperature. This approach causes no operational difficulties, since the boiling water reactor 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 are applicable for a coolant heatup and cooldown temperature rate of **≤ 100°F/hr**. However, the core not critical and the core critical curves were also developed to bound transients defined on the RPV thermal cycle diagram and the nozzle thermal cycle diagrams. For the hydrostatic pressure and leak test curve (Curve A), a coolant heatup and cooldown temperature rate of **≤ 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. Thus, 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 nil-ductility transition reference temperature (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 Tables 10, 11, and 12 for 28, 36 and 46 EFPY, respectively (Reference 6.7). The initial RT_{NDT} values were determined and reported to the NRC in the NMP1 responses to NRC Generic Letter (GL) 92-01, Revision 1 (Reference 6.8) and GL 92-01, Revision 1, Supplement 1 (Reference 6.9). The NRC acknowledged these GL responses in letters dated March 30, 1994, August 26, 1996, and June 25, 1999 (References 6.10, 6.11, and 6.12, respectively). The initial RT_{NDT} values shown in

Tables 10, 11, and 12 have previously been used in establishing the current TS P-T limit curves (license amendment approved by the NRC in Reference 6.5) and in evaluations contained in the License Renewal Application (approved by the NRC in Reference 6.13).

Per Reference 6.7 and in accordance with Appendix A of Reference 6.1, the NMP1 representative weld and plate surveillance materials data from the Boiling Water Reactor Vessel and Internals Project (BWRVIP) Integrated Surveillance Program (ISP) were reviewed. The representative heats of plate materials (P2112 and P2130) in the ISP are the same as the lower shell plate material in the vessel beltline region of NMP1. For plate heat P2112, since the scatter in the fitted results exceeds 1-sigma (17°F), the full 2-sigma margin term has been utilized in calculating the ART value for this plate in the vessel. For plate heat P2130, since the surveillance data was found to be credible, the margin term (σ_Δ = 17°F) is divided by two for the plate material when calculating the ART. Therefore, the CFs from the NRC's Reactor Vessel Integrity Database (Reference 6.14) and Reference 6.6 were used in the determination of ART for all NMP1 materials except for plate heat P2130.

The only computer code used in the determination of the NMP1 P-T curves was the ANSYS/Mechanical Release 6.1 (with Service Packs 2 and 3) finite element computer program (Reference 6.15) for the feedwater nozzle (non-beltline) stresses. This analysis was performed to determine through-wall thermal and pressure stress distributions for the NMP1 feedwater nozzles due to a step-change thermal transient (Reference 6.16). The ANSYS program was controlled under the vendor's 10 CFR 50 Appendix B Quality Assurance Program for nuclear quality-related work. Benchmarking consistent with NRC Generic Letter 83-11, Supplement 1 (Reference 6.17), 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 following inputs were used in the finite element analysis:

- With respect to operating conditions, stress distributions were developed for a thermal shock of 450°F, which represents the maximum thermal shock for the feedwater nozzle during normal operating conditions. The stress results for a 450°F shock are appropriate for use in developing the non-beltline P-T curves based on the limiting feedwater nozzle, as a shock of 450°F is representative of the Turbine Roll transient that occurs in the feedwater nozzle as part of the 100°F/hr startup transient. Therefore, these 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 calculated from the governing design basis stress report for the NMP1 feedwater nozzle and from a model of the heat transfer coefficient as a function of flow rate, as shown in Table 13 (Reference 6.16). The heat transfer coefficients were evaluated at flow rates that bound the actual operating conditions in the feedwater nozzles at NMP1.
- A two-dimensional, axisymmetric finite element model of the feedwater nozzle was constructed (Figure 10) using the same modeling techniques that were employed to evaluate the feedwater nozzle in the governing design basis report. In order to properly model the feedwater nozzle, the analysis was performed as a penetration in a sphere and not in a cylinder. To make up for this difference in geometry, a conversion factor of 3.2 times the cylinder radius was used to model the sphere (Reference 6.16). Material properties were evaluated at 325°F (Table 14) to conservatively bound the 100°F condition where the maximum stress occurred.

6.0 REFERENCES

1. Structural Integrity Associates Report No. SIR-05-044-A, Revision 0, "Pressure-Temperature Limits Report Methodology for Boiling Water Reactors," April 2007.
2. Structural Integrity Associates Calculation No. 0800297.301, Revision 1, "Revised Pressure-Temperature Curves," January 2009.
3. NRC Regulatory Guide 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," March 2001.
4. "Neutron Transport Analysis for Nine Mile Point Unit 1," Report Number MPM-405778, MPM Technologies, May 2006.
5. NRC Letter to NMPNS dated October 27, 2003, "Nine Mile Point Nuclear Station, Unit No. 1, Issuance of Amendment Re: Pressure-Temperature Limit Curves (TAC No. MB6687)."
6. NRC Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," May 1988.
7. Structural Integrity Associates Calculation No. 0800297.300, Revision 1, "Evaluation of Adjusted Reference Temperature Shifts," August 2008.
8. NRC Generic Letter 92-01, Revision 1, "Reactor Vessel Structural Integrity," March 6, 1992.

9. NRC Generic Letter 92-01, Revision 1, Supplement 1, "Reactor Vessel Structural Integrity," May 19, 1995.
10. NRC Letter to Niagara Mohawk Power Corporation (NMPC) dated March 30, 1994, "Generic Letter (GL) 92-01, Revision 1, 'Reactor Vessel Structural Integrity,' Nine Mile Point Nuclear Station Unit No. 1 (NMP-1) (TAC No. M83486)."
11. NRC Letter to NMPC dated August 26, 1996, "Closeout for Niagara Mohawk Power Corporation (NMPC) Response to Generic Letter 92-01, Revision 1, Supplement 1 for the Nine Mile Point Nuclear Station, Unit Nos. 1 & 2 (TAC Nos. M92700 and M927001)."
12. NRC Letter to NMPC dated June 25, 1999, "Response to Request for Additional Information Regarding Generic Letter 92-01, Revision 1, Supplement 1, 'Reactor Vessel Structural Integrity,' Nine Mile Point Nuclear Station, Unit Nos. 1 & 2 (TAC Nos. MA1200 and MA1201)."
13. NUREG-1900, "Safety Evaluation Report Related to the License Renewal of Nine Mile Point Nuclear Station, Units 1 and 2," September 2006.
14. U. S. Nuclear Regulatory Commission, "Reactor Vessel Integrity Database Version 2.0.1," September 7, 2000.
15. ANSYS/Mechanical Release 6.1 (w/Service Packs 2 and 3), ANSYS, Inc., April 2002.
16. Structural Integrity Associates Calculation No. NMP-09Q-302, Revision 0, "Feedwater Nozzle Green's Functions for Nine Mile Point Unit 1."
17. NRC Generic Letter 83-11, Supplement 1, "Licensee Qualification for Performing Safety Analyses," June 24, 1999.
18. NRC Letter to NMPNS dated November 8, 2004, "Nine Mile Point Nuclear Station Unit Nos. 1 and 2 – Issuance of Amendments Re: Implementation of the Reactor Pressure Vessel Integrated Surveillance Program (TAC Nos. MC1758 and MC1759)."
19. G.E. Drawing No. 237E434, "Loadings Reactor Vessel."

Figure 1: NMP1 Pressure Test (Curve A), 28 EFPY

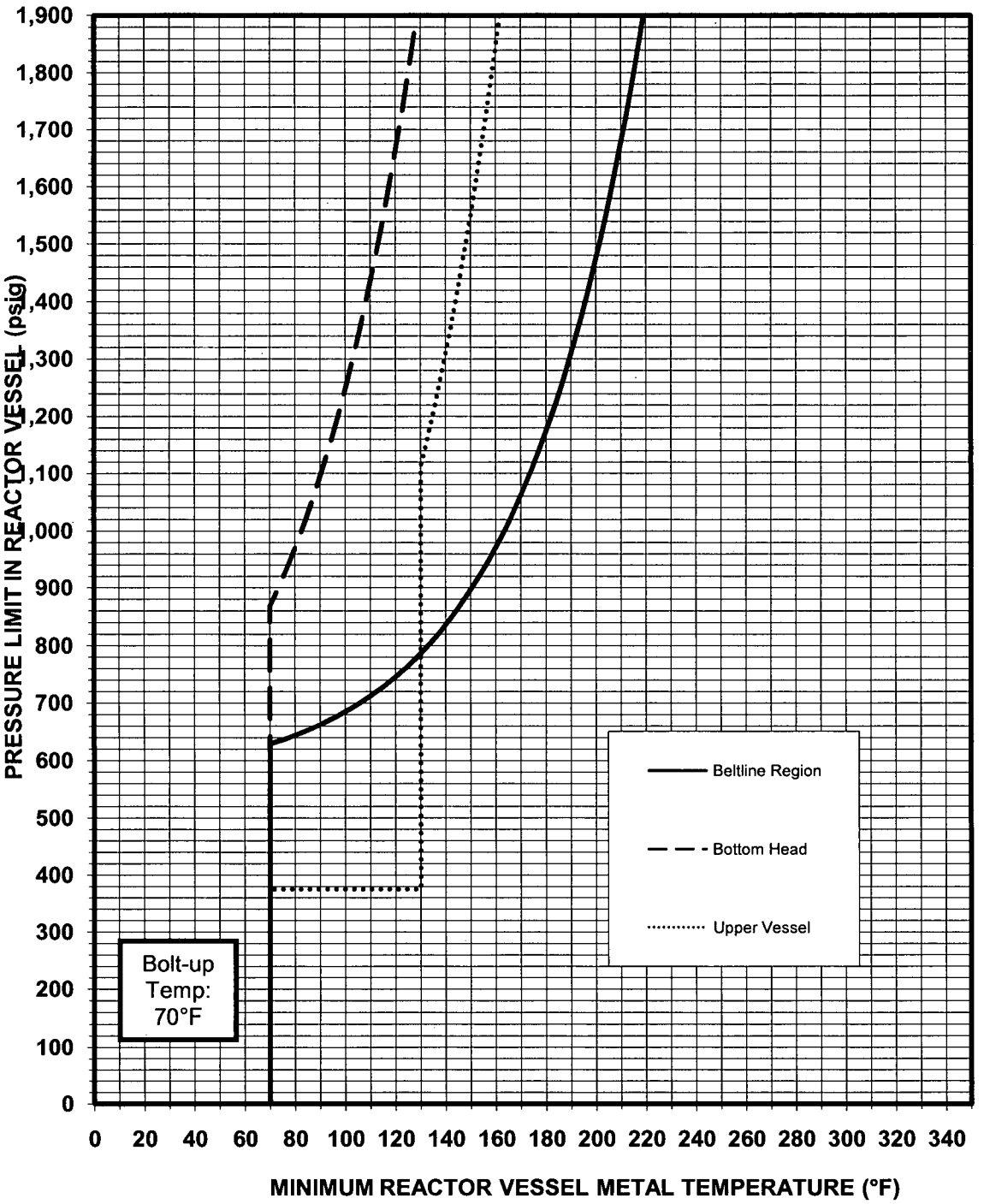

Figure 2: NMP1 Normal Operation (Heatup and Cooldown) - Core Not Critical (Curve B), 28 EFPY

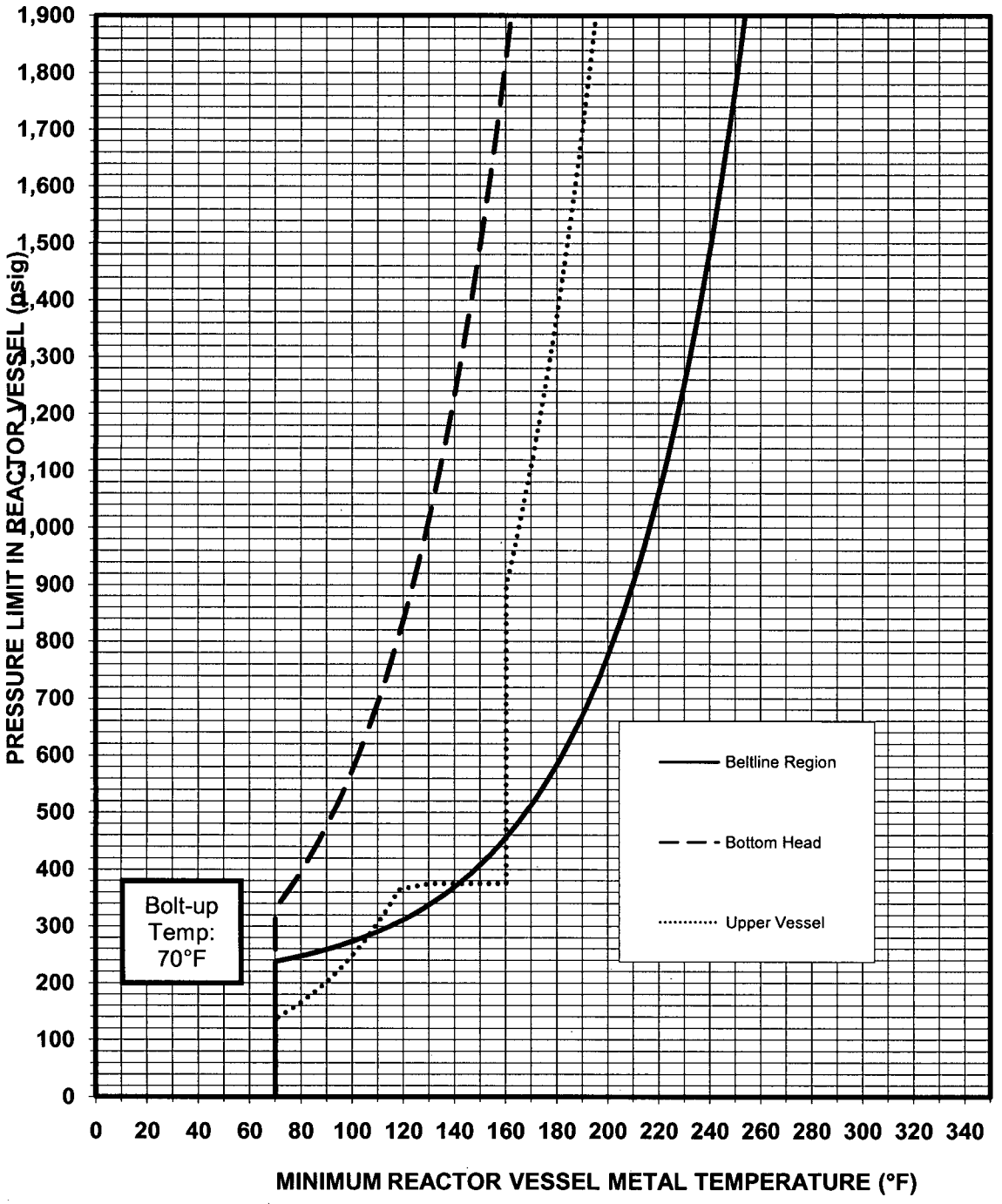

Figure 3: NMP1 Normal Operation (Heatup and Cooldown) - Core Critical (Curve C), 28 EFPY

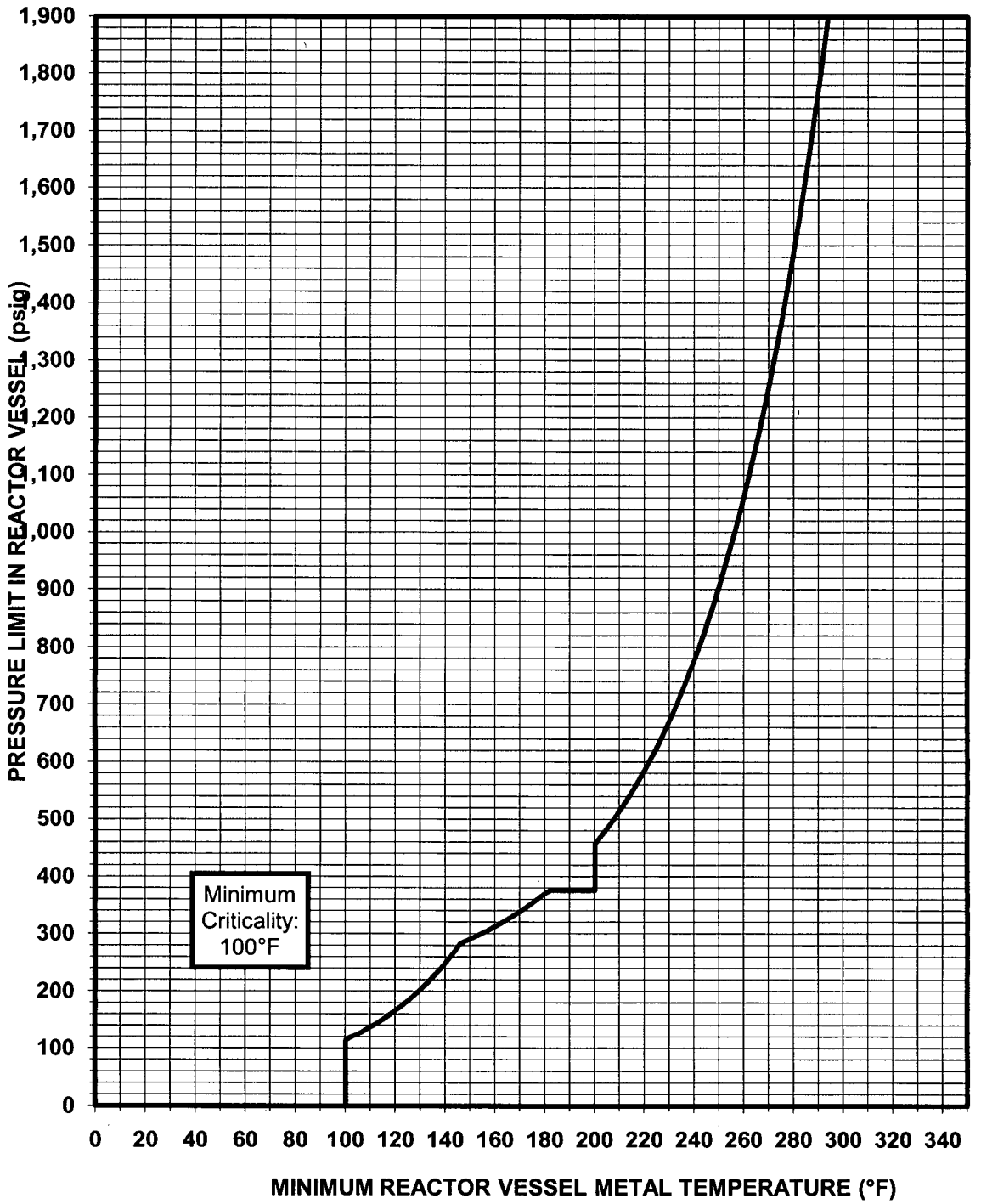

Figure 4: NMP1 Pressure Test (Curve A), 36 EFPY

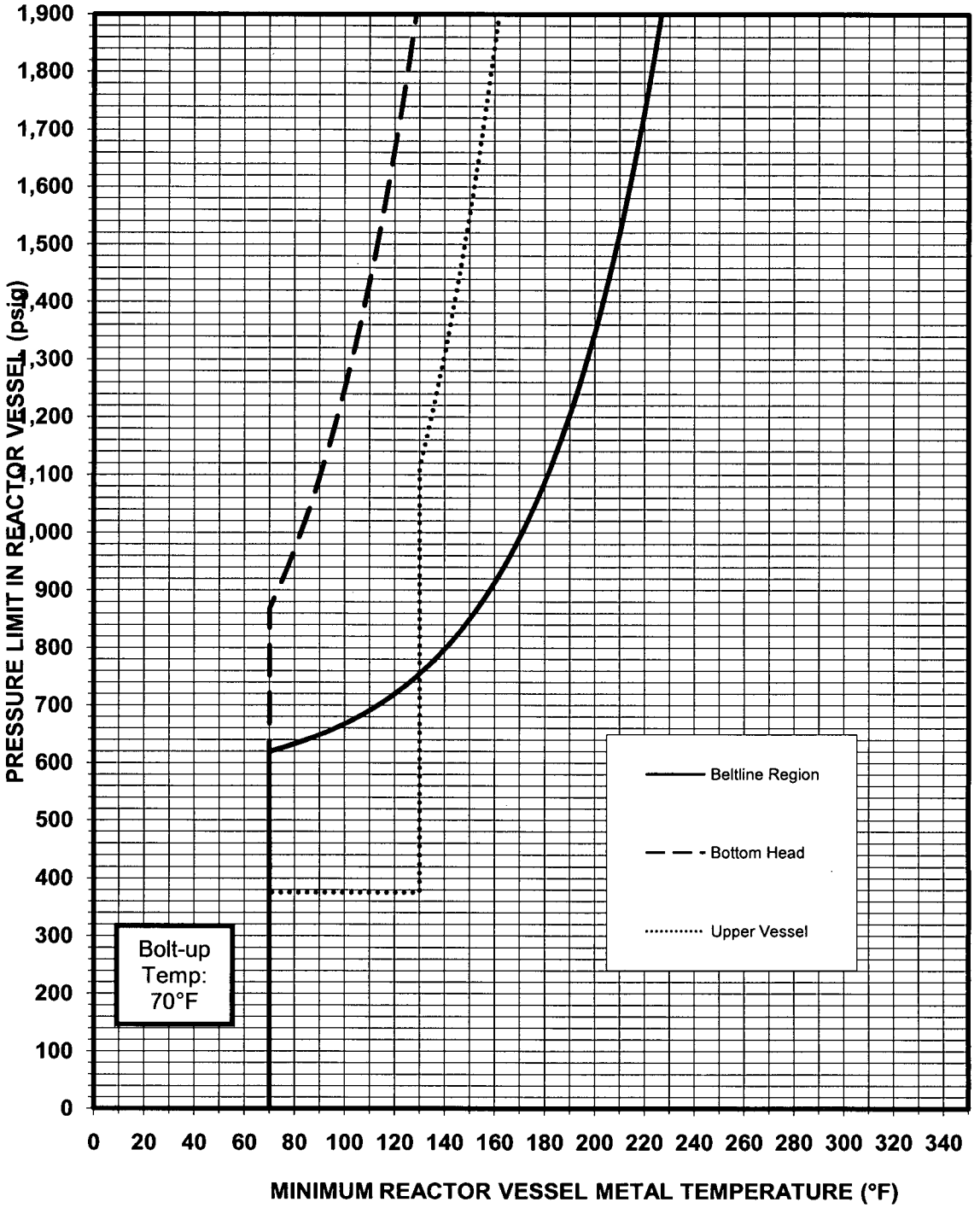

Figure 5: NMP1 Normal Operation (Heatup and Cooldown) - Core Not Critical (Curve B), 36 EFPY

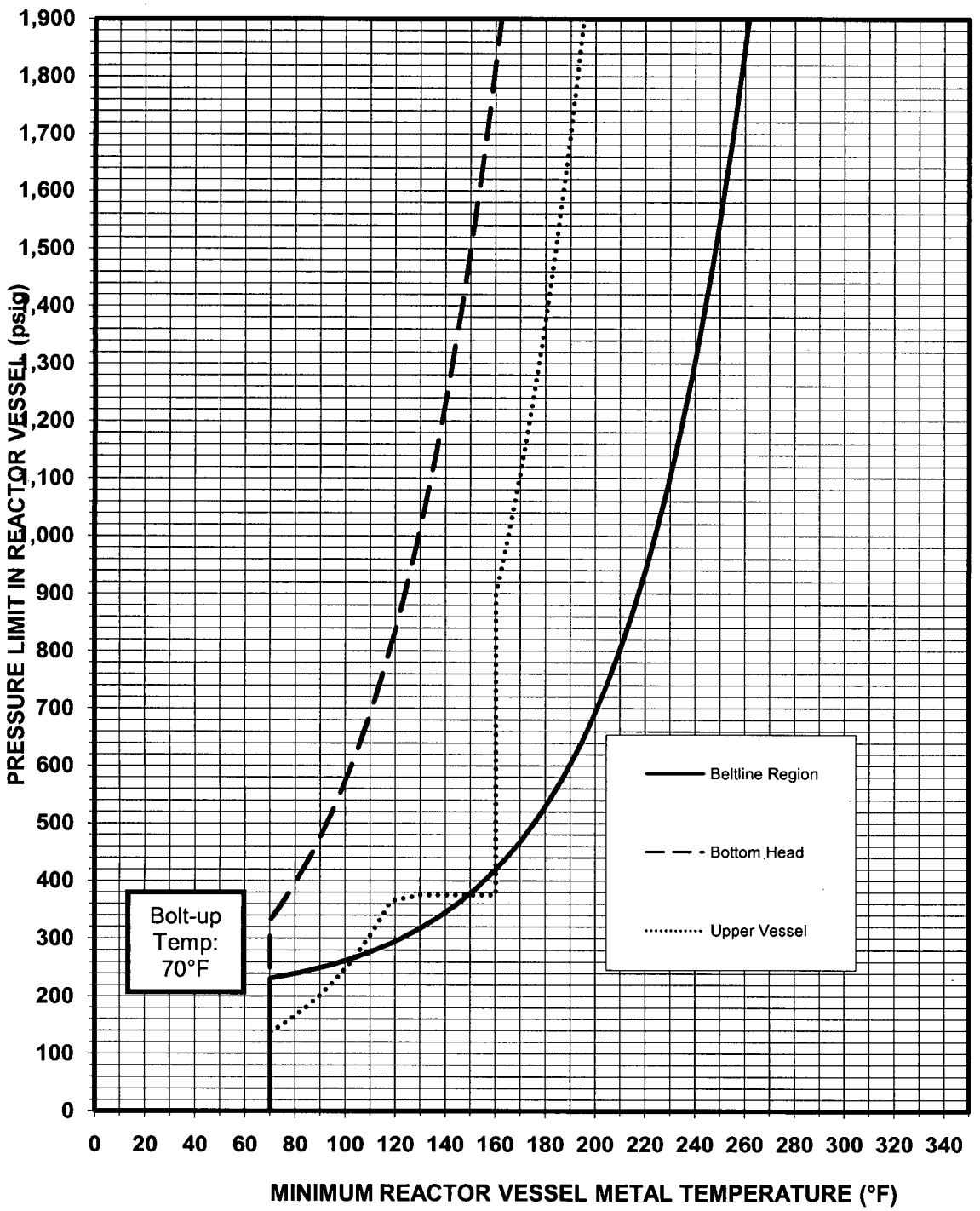

Figure 6: NMP1 Normal Operation (Heatup and Cooldown) - Core Critical (Curve C), 36 EFPY

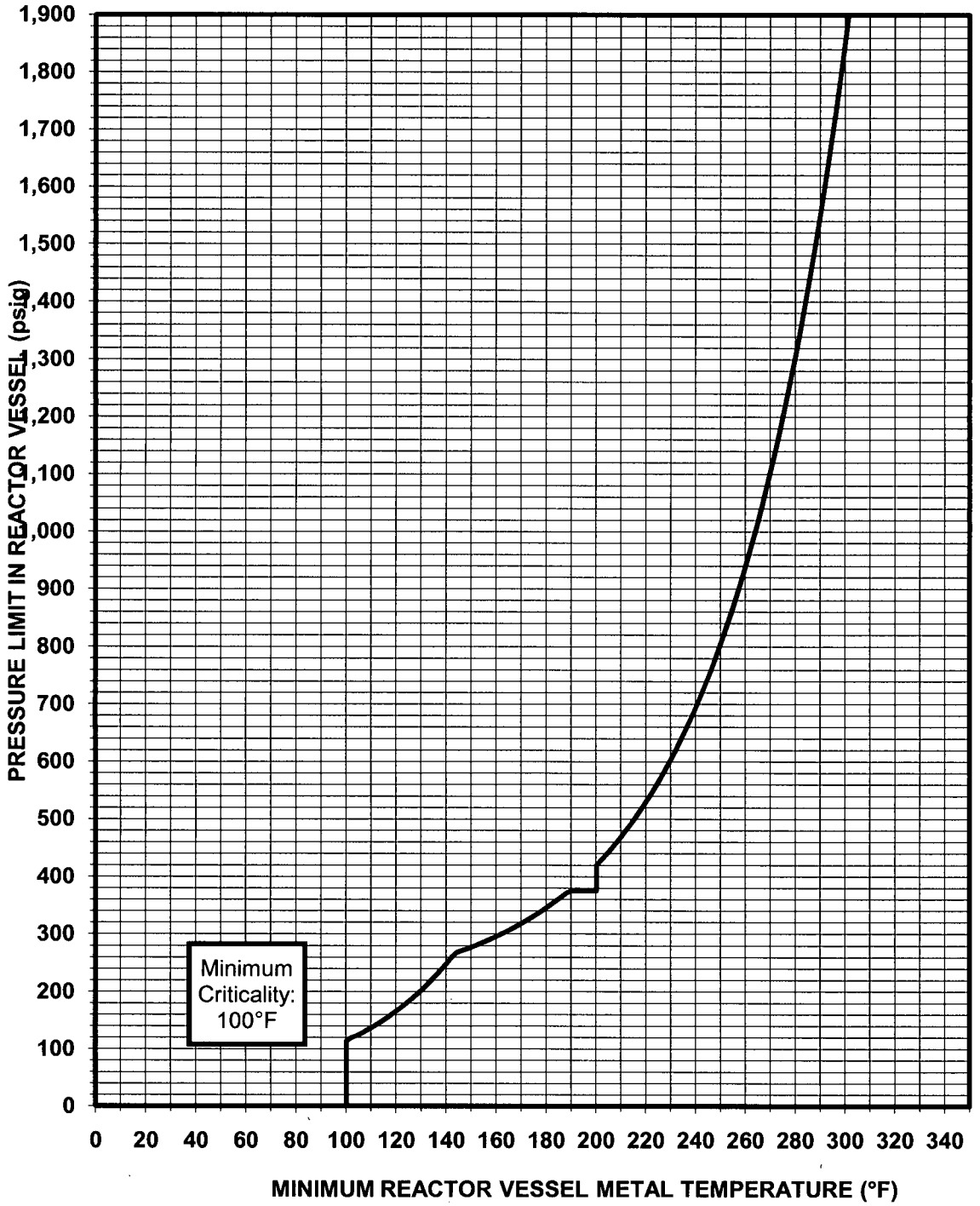

Figure 7: NMP1 Pressure Test (Curve A), 46 EFPY

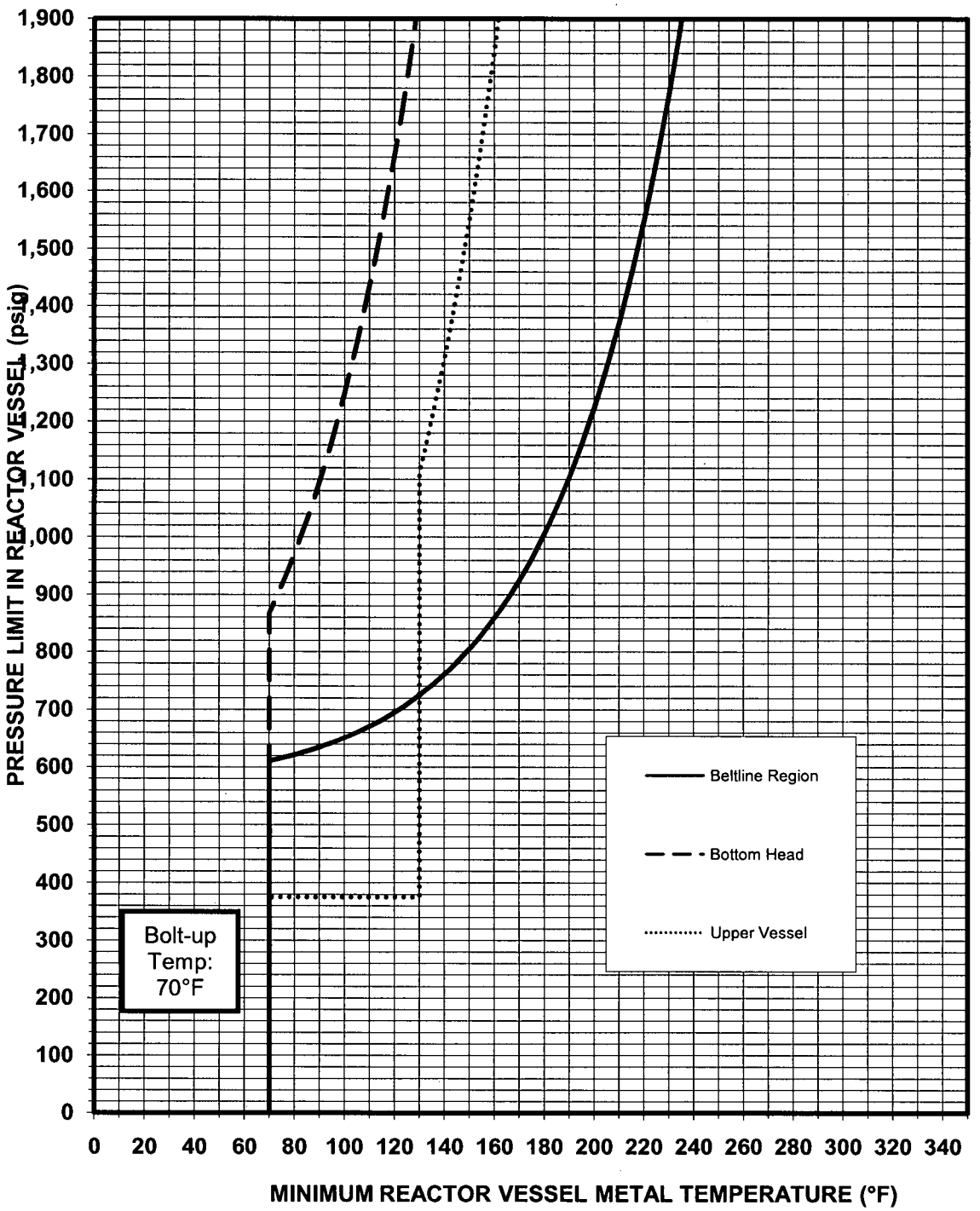

Figure 8: NMP1 Normal Operation (Heatup and Cooldown) - Core Not Critical (Curve B), 46 EFPY

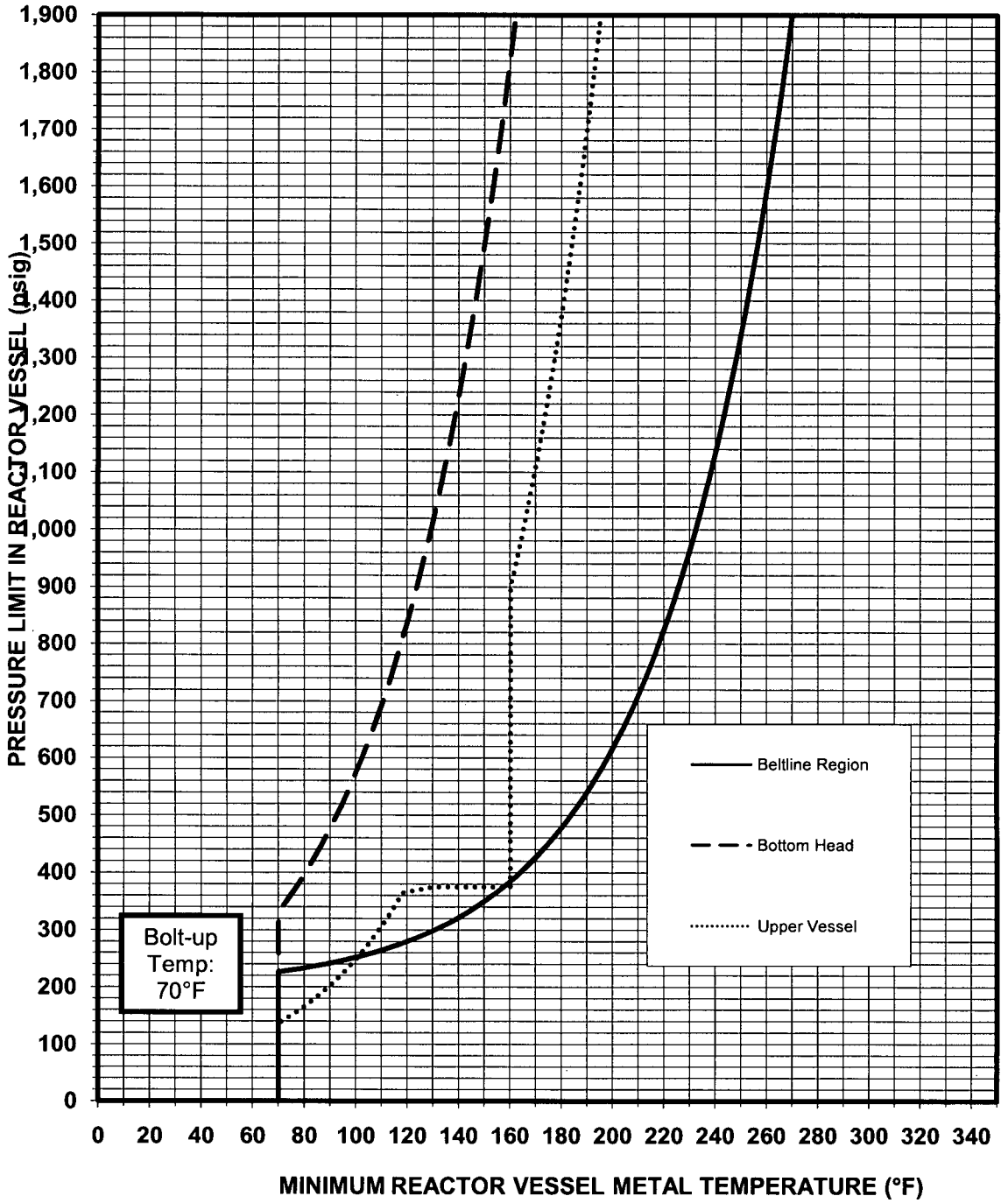

Figure 9: NMP1 Normal Operation (Heatup and Cooldown) - Core Critical (Curve C), 46 EFPY

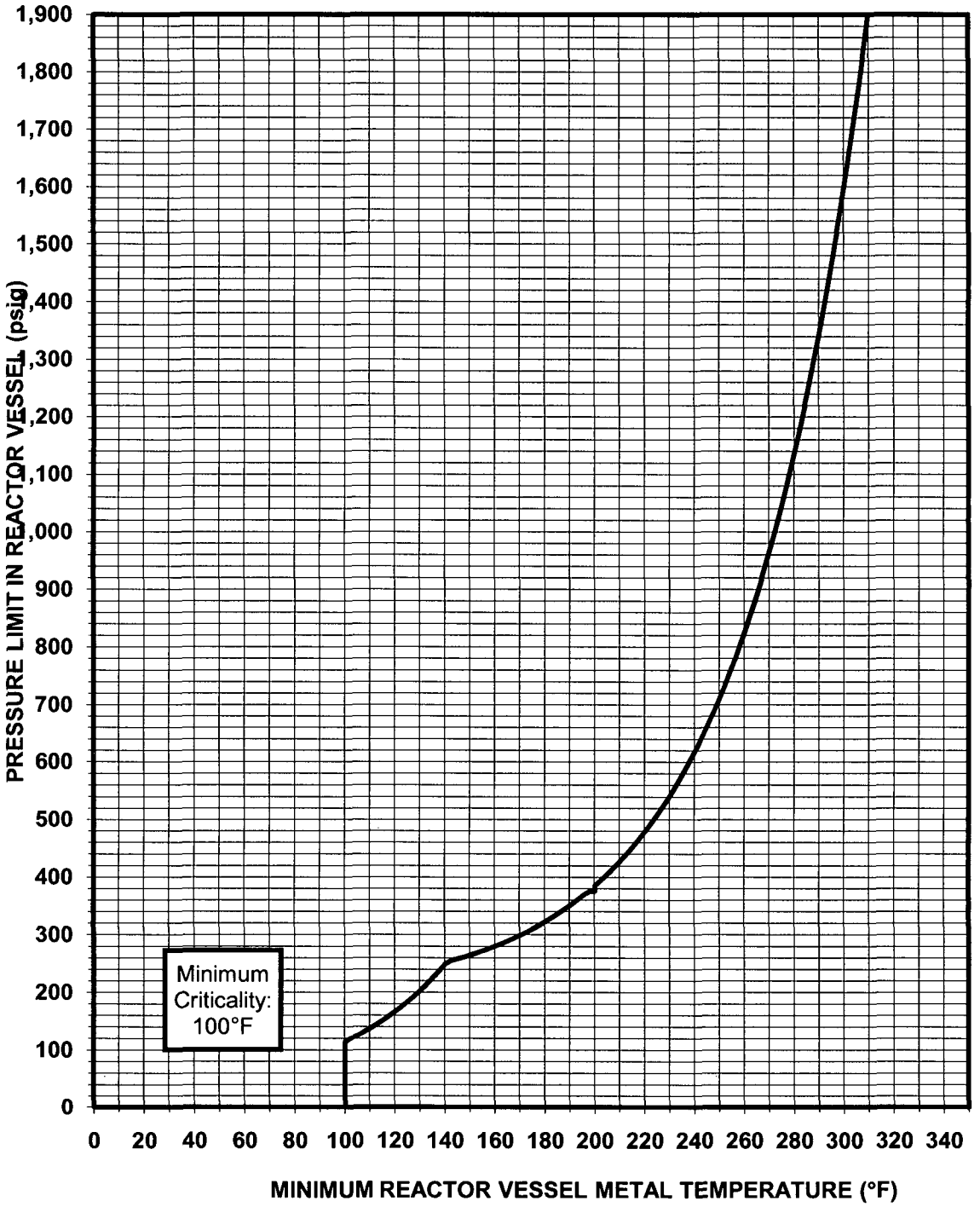

Figure 10: NMP1 Feedwater Nozzle Finite Element Model

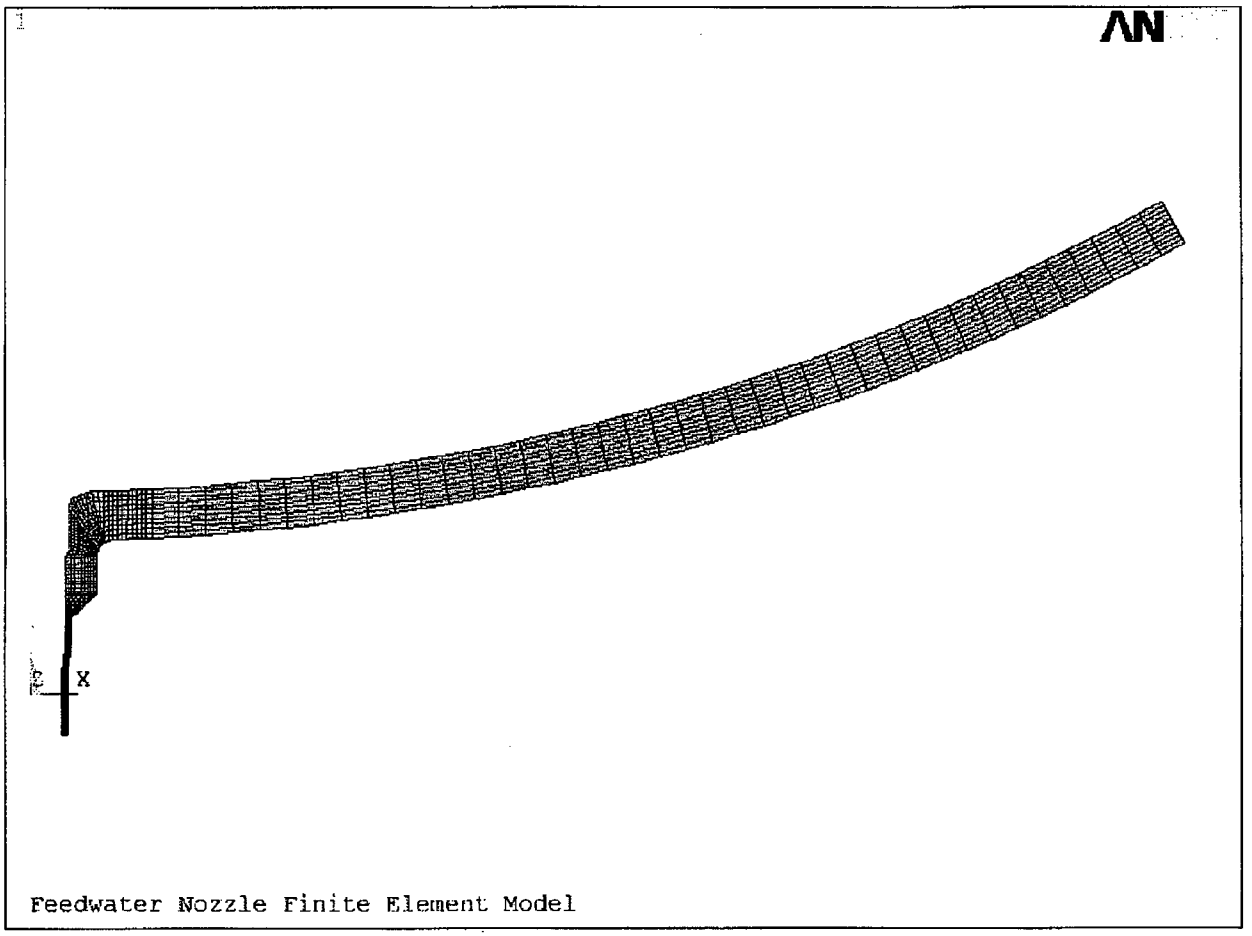

Table 1: NMP1 Pressure Test (Curve A) - Beltline Region, 28 EFPY

Plant =	NMP1	
Component =	Beltline	
Vessel thickness, t =	7.125	inches
Vessel Radius, R =	106.5	inches
ART =	151.4	°F =====> 28 EFPY
K_{It} =	0	(no thermal effects)
Safety Factor =	1.5	
M_m =	2.472	
Temperature Adjustment =	4.0	°F (instrument uncertainty)
Pressure Adjustment =	27.7	psig (hydrostatic pressure head for a full vessel at 70°F)
Pressure Adjustment =	10.0	psig (instrument uncertainty)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
56	36.28	24.18	0	70	0
56	36.28	24.18	655	70	617
58	36.40	24.27	657	70	619
60	36.53	24.36	659	70	622
62	36.67	24.45	662	70	624
64	36.81	24.54	664	70	627
66	36.96	24.64	667	70	629
68	37.11	24.74	670	72	632
70	37.27	24.85	673	74	635
72	37.44	24.96	676	76	638
74	37.61	25.07	679	78	641
76	37.79	25.19	682	80	644
78	37.98	25.32	685	82	648
80	38.17	25.45	689	84	651
82	38.37	25.58	692	86	655
84	38.59	25.72	696	88	659
86	38.81	25.87	700	90	663
88	39.03	26.02	704	92	667
90	39.27	26.18	709	94	671
92	39.52	26.35	713	96	675
94	39.78	26.52	718	98	680
96	40.05	26.70	723	100	685
98	40.33	26.88	728	102	690
100	40.62	27.08	733	104	695
102	40.92	27.28	738	106	701
104	41.23	27.49	744	108	706
106	41.56	27.71	750	110	712
108	41.90	27.94	756	112	718
110	42.26	28.17	763	114	725
112	42.63	28.42	769	116	732
114	43.01	28.68	776	118	738
116	43.41	28.94	783	120	746
118	43.83	29.22	791	122	753
120	44.26	29.51	799	124	761
122	44.72	29.81	807	126	769
124	45.19	30.12	815	128	778
126	45.68	30.45	824	130	787
128	46.18	30.79	833	132	796
130	46.71	31.14	843	134	805
132	47.27	31.51	853	136	815
134	47.84	31.89	863	138	826
136	48.44	32.29	874	140	836
138	49.06	32.71	885	142	848
140	49.71	33.14	897	144	859

Table 1 (Continued)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
142	50.38	33.59	909	146	871
144	51.08	34.05	922	148	884
146	51.81	34.54	935	150	897
148	52.57	35.05	949	152	911
150	53.36	35.57	963	154	925
152	54.18	36.12	978	156	940
154	55.04	36.69	993	158	956
156	55.93	37.29	1009	160	972
158	56.86	37.91	1026	162	988
160	57.83	38.55	1043	164	1006
162	58.83	39.22	1062	166	1024
164	59.88	39.92	1080	168	1043
166	60.96	40.64	1100	170	1062
168	62.10	41.40	1121	172	1083
170	63.28	42.18	1142	174	1104
172	64.50	43.00	1164	176	1126
174	65.78	43.85	1187	178	1149
176	67.11	44.74	1211	180	1173
178	68.50	45.66	1236	182	1198
180	69.94	46.62	1262	184	1224
182	71.44	47.62	1289	186	1251
184	73.00	48.66	1317	188	1280
186	74.62	49.75	1346	190	1309
188	76.31	50.87	1377	192	1339
190	78.07	52.05	1409	194	1371
192	79.90	53.27	1442	196	1404
194	81.81	54.54	1476	198	1438
196	83.79	55.86	1512	200	1474
198	85.86	57.24	1549	202	1512
200	88.00	58.67	1588	204	1550
202	90.24	60.16	1628	206	1591
204	92.57	61.71	1670	208	1633
206	94.99	63.33	1714	210	1676
208	97.51	65.01	1760	212	1722
210	100.14	66.76	1807	214	1769
212	102.87	68.58	1856	216	1819
214	105.71	70.48	1908	218	1870
216	108.67	72.45	1961	220	1923

Table 2: NMP1 Normal Operation – Core Not Critical (Curve B), Beltline Region, 28 EFPY

Plant =	NMP1		
Component =	Beltline		
Vessel thickness, t =	7.125	inches	
Vessel Radius, R =	106.5	inches	
ART =	151.4	°F =====>	28 EFPY
K_{It} =	12.91	ksi??in	
Safety Factor =	2.0		
M_m =	2.472		
Temperature Adjustment =	12.2	°F (instrument uncertainty)	
Pressure Adjustment =	27.7	psig (hydrostatic pressure head for a full vessel at 70°F)	
Pressure Adjustment =	52.2	psig (instrument uncertainty)	
Heat Up and Cool Down Rate =	100	°F/Hr	

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
48	35.82	11.45	310	70	0
48	35.82	11.45	310	70	230
50	35.93	11.51	311	70	232
52	36.04	11.56	313	70	233
54	36.16	11.62	315	70	235
56	36.28	11.68	316	70	236
58	36.40	11.74	318	70	238
60	36.53	11.81	320	72	240
62	36.67	11.88	321	74	242
64	36.81	11.95	323	76	244
66	36.96	12.02	325	78	246
68	37.11	12.10	327	80	248
70	37.27	12.18	330	82	250
72	37.44	12.26	332	84	252
74	37.61	12.35	334	86	254
76	37.79	12.44	337	88	257
78	37.98	12.53	339	90	259
80	38.17	12.63	342	92	262
82	38.37	12.73	345	94	265
84	38.59	12.84	347	96	268
86	38.81	12.95	350	98	271
88	39.03	13.06	353	100	274
90	39.27	13.18	357	102	277
92	39.52	13.30	360	104	280
94	39.78	13.43	364	106	284
96	40.05	13.57	367	108	287
98	40.33	13.71	371	110	291
100	40.62	13.85	375	112	295
102	40.92	14.00	379	114	299
104	41.23	14.16	383	116	303
106	41.56	14.32	388	118	308
108	41.90	14.50	392	120	312
110	42.26	14.67	397	122	317
112	42.63	14.86	402	124	322
114	43.01	15.05	407	126	327
116	43.41	15.25	413	128	333
118	43.83	15.46	418	130	339
120	44.26	15.68	424	132	344
122	44.72	15.90	430	134	351
124	45.19	16.14	437	136	357
126	45.68	16.38	443	138	364
128	46.18	16.64	450	140	370
130	46.71	16.90	457	142	378
132	47.27	17.18	465	144	385
134	47.84	17.46	473	146	393
136	48.44	17.76	481	148	401
138	49.06	18.07	489	150	409
140	49.71	18.40	498	152	418

Table 2 (Continued)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
142	50.38	18.73	507	154	427
144	51.08	19.08	517	156	437
146	51.81	19.45	526	158	447
148	52.57	19.83	537	160	457
150	53.36	20.22	547	162	468
152	54.18	20.64	559	164	479
154	55.04	21.06	570	166	490
156	55.93	21.51	582	168	502
158	56.86	21.97	595	170	515
160	57.83	22.46	608	172	528
162	58.83	22.96	621	174	542
164	59.88	23.48	636	176	556
166	60.96	24.03	650	178	570
168	62.10	24.59	666	180	586
170	63.28	25.18	682	182	602
172	64.50	25.80	698	184	618
174	65.78	26.43	715	186	636
176	67.11	27.10	733	188	654
178	68.50	27.79	752	190	672
180	69.94	28.51	772	192	692
182	71.44	29.26	792	194	712
184	73.00	30.04	813	196	733
186	74.62	30.85	835	198	755
188	76.31	31.70	858	200	778
190	78.07	32.58	882	202	802
192	79.90	33.49	907	204	827
194	81.81	34.45	932	206	852
196	83.79	35.44	959	208	879
198	85.86	36.47	987	210	907
200	88.00	37.55	1016	212	936
202	90.24	38.66	1046	214	967
204	92.57	39.83	1078	216	998
206	94.99	41.04	1111	218	1031
208	97.51	42.30	1145	220	1065
210	100.14	43.61	1180	222	1101
212	102.87	44.98	1217	224	1138
214	105.71	46.40	1256	226	1176
216	108.67	47.88	1296	228	1216
218	111.75	49.42	1338	230	1258
220	114.96	51.02	1381	232	1301
222	118.30	52.69	1426	234	1346
224	121.77	54.43	1473	236	1393
226	125.38	56.23	1522	238	1442
228	129.14	58.12	1573	240	1493
230	133.06	60.07	1626	242	1546
232	137.14	62.11	1681	244	1601
234	141.38	64.23	1739	246	1659
236	145.79	66.44	1798	248	1718
238	150.39	68.74	1860	250	1781
240	155.17	71.13	1925	252	1845
242	160.15	73.62	1993	254	1913

Table 3: NMP1 Normal Operation – Core Critical (Curve C), 28 EFPY

Plant =	NMP1	
Curve A Leak Test Temperature =	169.2	°F
Curve A Leak Test Pressure =	1,055	psig
Unit Pressure =	1,875	psig (hydrostatic pressure)
Flange RT_{NDT} =	40.0	°F

Adjusted P-T Curve Temperature (°F)	Adjusted P-T Curve Pressure (psig)
100	0
100	113
102	119
104	122
106	126
108	131
110	136
112	141
114	147
116	153
118	159
120	165
122	172
124	179
126	186
128	194
130	202
132	210
134	219
136	228
138	238
140	248
142	259
144	270
146	281
148	287
150	291
152	295
154	299
156	303
158	308
160	312
162	317
164	322
166	327
168	333
170	339
172	344
174	351
176	357
178	364
180	370
182	375
184	375
186	375
188	375
190	375

Table 3 (Continued)

Adjusted P-T Curve Temperature (°F)	Adjusted P-T Curve Pressure (psig)
192	375
194	375
196	375
198	375
200	375
200	457
202	468
204	479
206	490
208	502
210	515
212	528
214	542
216	556
218	570
220	586
222	602
224	618
226	636
228	654
230	672
232	692
234	712
236	733
238	755
240	778
242	802
244	827
246	852
248	879
250	907
252	936
254	967
256	998
258	1031
260	1065
262	1101
264	1138
266	1176
268	1216
270	1258
272	1301
274	1346
276	1393
278	1442
280	1493
282	1546
284	1601
286	1659
288	1718
290	1781
292	1845
294	1913

Table 4: NMP1 Pressure Test (Curve A) - Beltline Region, 36 EFPY

Plant =	NMP1		
Component =	Beltline		
Vessel thickness, t =	7.125	inches	
Vessel Radius, R =	106.5	inches	
ART =	159.0	°F =====>	36 EFPY
K_{It} =	0	(no thermal effects)	
Safety Factor =	1.5		
M_m =	2.472		
Temperature Adjustment =	4.0	°F (instrument uncertainty)	
Pressure Adjustment =	27.7	psig (hydrostatic pressure head for a full vessel at 70°F)	
Pressure Adjustment =	10.0	psig (instrument uncertainty)	

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
56	35.84	23.90	0	70	0
56	35.84	23.90	647	70	609
58	35.95	23.97	649	70	611
60	36.06	24.04	651	70	613
62	36.18	24.12	653	70	615
64	36.30	24.20	655	70	617
66	36.43	24.29	657	70	620
68	36.56	24.37	660	72	622
70	36.70	24.46	662	74	625
72	36.84	24.56	665	76	627
74	36.99	24.66	667	78	630
76	37.14	24.76	670	80	633
78	37.30	24.87	673	82	635
80	37.47	24.98	676	84	638
82	37.64	25.10	679	86	642
84	37.83	25.22	683	88	645
86	38.02	25.34	686	90	648
88	38.21	25.47	690	92	652
90	38.42	25.61	693	94	656
92	38.63	25.75	697	96	659
94	38.85	25.90	701	98	663
96	39.08	26.05	705	100	668
98	39.32	26.21	710	102	672
100	39.57	26.38	714	104	676
102	39.83	26.55	719	106	681
104	40.10	26.73	724	108	686
106	40.38	26.92	729	110	691
108	40.68	27.12	734	112	696
110	40.98	27.32	739	114	702
112	41.30	27.53	745	116	708
114	41.63	27.75	751	118	714
116	41.97	27.98	757	120	720
118	42.33	28.22	764	122	726
120	42.70	28.47	771	124	733
122	43.09	28.73	778	126	740
124	43.50	29.00	785	128	747
126	43.92	29.28	792	130	755
128	44.35	29.57	800	132	763
130	44.81	29.87	809	134	771
132	45.28	30.19	817	136	779
134	45.78	30.52	826	138	788
136	46.29	30.86	835	140	798
138	46.82	31.22	845	142	807
140	47.38	31.59	855	144	817

Table 4 (Continued)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
142	47.96	31.97	865	146	828
144	48.56	32.37	876	148	839
146	49.19	32.79	888	150	850
148	49.84	33.23	899	152	862
150	50.52	33.68	912	154	874
152	51.23	34.15	924	156	887
154	51.96	34.64	938	158	900
156	52.73	35.15	951	160	914
158	53.52	35.68	966	162	928
160	54.35	36.24	981	164	943
162	55.22	36.81	996	166	959
164	56.11	37.41	1013	168	975
166	57.05	38.03	1029	170	992
168	58.02	38.68	1047	172	1009
170	59.04	39.36	1065	174	1028
172	60.09	40.06	1084	176	1047
174	61.19	40.79	1104	178	1066
176	62.33	41.55	1125	180	1087
178	63.52	42.35	1146	182	1108
180	64.76	43.17	1168	184	1131
182	66.04	44.03	1192	186	1154
184	67.38	44.92	1216	188	1178
186	68.78	45.85	1241	190	1203
188	70.23	46.82	1267	192	1230
190	71.74	47.83	1295	194	1257
192	73.32	48.88	1323	196	1285
194	74.95	49.97	1352	198	1315
196	76.66	51.10	1383	200	1346
198	78.43	52.29	1415	202	1378
200	80.28	53.52	1449	204	1411
202	82.20	54.80	1483	206	1446
204	84.20	56.13	1519	208	1482
206	86.28	57.52	1557	210	1519
208	88.44	58.96	1596	212	1558
210	90.70	60.47	1637	214	1599
212	93.05	62.03	1679	216	1641
214	95.49	63.66	1723	218	1685
216	98.03	65.35	1769	220	1731
218	100.68	67.12	1817	222	1779
220	103.43	68.95	1866	224	1829
222	106.30	70.86	1918	226	1880
224	109.28	72.85	1972	228	1934

Table 5: NMP1 Normal Operation – Core Not Critical (Curve B), Beltline Region, 36 EFPY

Plant =	NMP1		
Component =	Beltline		
Vessel thickness, t =	7.125	inches	
Vessel Radius, R =	106.5	inches	
ART =	159.0	°F =====>	36 EFPY
K_{It} =	12.91	ksi??in	
Safety Factor =	2.0		
M_m =	2.472		
Temperature Adjustment =	12.2	°F (instrument uncertainty)	
Pressure Adjustment =	27.7	psig (hydrostatic pressure head for a full vessel at 70°F)	
Pressure Adjustment =	52.2	psig (instrument uncertainty)	
Heat Up and Cool Down Rate =	100	°F/Hr	

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
48	35.45	11.27	305	70	0
48	35.45	11.27	305	70	225
50	35.54	11.31	306	70	226
52	35.64	11.36	308	70	228
54	35.74	11.41	309	70	229
56	35.84	11.46	310	70	230
58	35.95	11.52	312	70	232
60	36.06	11.57	313	72	233
62	36.18	11.63	315	74	235
64	36.30	11.69	317	76	237
66	36.43	11.76	318	78	238
68	36.56	11.82	320	80	240
70	36.70	11.89	322	82	242
72	36.84	11.96	324	84	244
74	36.99	12.04	326	86	246
76	37.14	12.11	328	88	248
78	37.30	12.19	330	90	250
80	37.47	12.28	332	92	252
82	37.64	12.37	335	94	255
84	37.83	12.46	337	96	257
86	38.02	12.55	340	98	260
88	38.21	12.65	342	100	263
90	38.42	12.75	345	102	265
92	38.63	12.86	348	104	268
94	38.85	12.97	351	106	271
96	39.08	13.08	354	108	274
98	39.32	13.20	357	110	278
100	39.57	13.33	361	112	281
102	39.83	13.46	364	114	284
104	40.10	13.59	368	116	288
106	40.38	13.73	372	118	292
108	40.68	13.88	376	120	296
110	40.98	14.03	380	122	300
112	41.30	14.19	384	124	304
114	41.63	14.36	389	126	309
116	41.97	14.53	393	128	313
118	42.33	14.71	398	130	318
120	42.70	14.90	403	132	323
122	43.09	15.09	408	134	329
124	43.50	15.29	414	136	334
126	43.92	15.50	420	138	340
128	44.35	15.72	425	140	346
130	44.81	15.95	432	142	352
132	45.28	16.18	438	144	358
134	45.78	16.43	445	146	365
136	46.29	16.69	452	148	372
138	46.82	16.95	459	150	379
140	47.38	17.23	466	152	387

Table 5 (Continued)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
142	47.96	17.52	474	154	394
144	48.56	17.82	482	156	403
146	49.19	18.14	491	158	411
148	49.84	18.46	500	160	420
150	50.52	18.80	509	162	429
152	51.23	19.16	518	164	439
154	51.96	19.52	528	166	449
156	52.73	19.91	539	168	459
158	53.52	20.30	550	170	470
160	54.35	20.72	561	172	481
162	55.22	21.15	572	174	493
164	56.11	21.60	585	176	505
166	57.05	22.07	597	178	517
168	58.02	22.55	610	180	531
170	59.04	23.06	624	182	544
172	60.09	23.59	638	184	559
174	61.19	24.14	653	186	573
176	62.33	24.71	669	188	589
178	63.52	25.30	685	190	605
180	64.76	25.92	702	192	622
182	66.04	26.57	719	194	639
184	67.38	27.24	737	196	657
186	68.78	27.93	756	198	676
188	70.23	28.66	776	200	696
190	71.74	29.41	796	202	716
192	73.32	30.20	817	204	738
194	74.95	31.02	840	206	760
196	76.66	31.87	863	208	783
198	78.43	32.76	887	210	807
200	80.28	33.68	912	212	832
202	82.20	34.64	938	214	858
204	84.20	35.64	965	216	885
206	86.28	36.68	993	218	913
208	88.44	37.77	1022	220	942
210	90.70	38.89	1053	222	973
212	93.05	40.07	1084	224	1005
214	95.49	41.29	1118	226	1038
216	98.03	42.56	1152	228	1072
218	100.68	43.88	1188	230	1108
220	103.43	45.26	1225	232	1145
222	106.30	46.69	1264	234	1184
224	109.28	48.18	1304	236	1224
226	112.38	49.74	1346	238	1266
228	115.62	51.35	1390	240	1310
230	118.98	53.03	1435	242	1356
232	122.48	54.78	1483	244	1403
234	126.12	56.60	1532	246	1452
236	129.92	58.50	1583	248	1504
238	133.86	60.47	1637	250	1557
240	137.97	62.53	1692	252	1613
242	142.25	64.67	1750	254	1670
244	146.70	66.89	1811	256	1731
246	151.33	69.21	1873	258	1793
248	156.15	71.62	1938	260	1859
250	161.17	74.13	2006	262	1926

Table 6: NMP1 Normal Operation – Core Critical (Curve C), 36 EFPY

Plant =	NMP1	
Curve A Leak Test Temperature =	176.8	°F
Curve A Leak Test Pressure =	1,055	psig
Unit Pressure =	1,875	psig (hydrostatic pressure)
Flange RT_{NDT} =	40.0	°F

Adjusted P-T Curve Temperature (°F)	Adjusted P-T Curve Pressure (psig)
100	0
100	113
102	119
104	122
106	126
108	131
110	136
112	141
114	147
116	153
118	159
120	165
122	172
124	179
126	186
128	194
130	202
132	210
134	219
136	228
138	238
140	248
142	259
144	268
146	271
148	274
150	278
152	281
154	284
156	288
158	292
160	296
162	300
164	304
166	309
168	313
170	318
172	323
174	329
176	334
178	340
180	346
182	352
184	358
186	365
188	372
190	375

Table 6 (Continued)

Adjusted P-T Curve Temperature (°F)	Adjusted P-T Curve Pressure (psig)
192	375
194	375
196	375
198	375
200	375
200	420
202	429
204	439
206	449
208	459
210	470
212	481
214	493
216	505
218	517
220	531
222	544
224	559
226	573
228	589
230	605
232	622
234	639
236	657
238	676
240	696
242	716
244	738
246	760
248	783
250	807
252	832
254	858
256	885
258	913
260	942
262	973
264	1005
266	1038
268	1072
270	1108
272	1145
274	1184
276	1224
278	1266
280	1310
282	1356
284	1403
286	1452
288	1504
290	1557
292	1613
294	1670
296	1731
298	1793
300	1859
302	1926

Table 7: NMP1 Pressure Test (Curve A) - Beltline Region, 46 EFPY

Plant =	NMP1	
Component =	Beltline	
Vessel thickness, t =	7.125	inches
Vessel Radius, R =	106.5	inches
ART =	167.4	°F =====> 46 EFPY
K_{It} =	0	(no thermal effects)
Safety Factor =	1.5	
M_m =	2.472	
Temperature Adjustment =	4.0	°F (instrument uncertainty)
Pressure Adjustment =	27.7	psig (hydrostatic pressure head for a full vessel at 70°F)
Pressure Adjustment =	10.0	psig (instrument uncertainty)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
56	35.43	23.62	0	70	0
56	35.43	23.62	639	70	602
58	35.53	23.68	641	70	603
60	35.62	23.75	643	70	605
62	35.72	23.81	645	70	607
64	35.82	23.88	646	70	609
66	35.93	23.95	648	70	611
68	36.04	24.03	650	72	613
70	36.16	24.10	652	74	615
72	36.28	24.18	655	76	617
74	36.40	24.27	657	78	619
76	36.53	24.36	659	80	622
78	36.67	24.45	662	82	624
80	36.81	24.54	664	84	627
82	36.96	24.64	667	86	629
84	37.11	24.74	670	88	632
86	37.27	24.85	673	90	635
88	37.44	24.96	676	92	638
90	37.61	25.07	679	94	641
92	37.79	25.19	682	96	644
94	37.98	25.32	685	98	648
96	38.17	25.45	689	100	651
98	38.37	25.58	692	102	655
100	38.59	25.72	696	104	659
102	38.81	25.87	700	106	663
104	39.03	26.02	704	108	667
106	39.27	26.18	709	110	671
108	39.52	26.35	713	112	675
110	39.78	26.52	718	114	680
112	40.05	26.70	723	116	685
114	40.33	26.88	728	118	690
116	40.62	27.08	733	120	695
118	40.92	27.28	738	122	701
120	41.23	27.49	744	124	706
122	41.56	27.71	750	126	712
124	41.90	27.94	756	128	718
126	42.26	28.17	763	130	725
128	42.63	28.42	769	132	732
130	43.01	28.68	776	134	738
132	43.41	28.94	783	136	746
134	43.83	29.22	791	138	753
136	44.26	29.51	799	140	761
138	44.72	29.81	807	142	769
140	45.19	30.12	815	144	778

Table 7 (Continued)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
142	45.68	30.45	824	146	787
144	46.18	30.79	833	148	796
146	46.71	31.14	843	150	805
148	47.27	31.51	853	152	815
150	47.84	31.89	863	154	826
152	48.44	32.29	874	156	836
154	49.06	32.71	885	158	848
156	49.71	33.14	897	160	859
158	50.38	33.59	909	162	871
160	51.08	34.05	922	164	884
162	51.81	34.54	935	166	897
164	52.57	35.05	949	168	911
166	53.36	35.57	963	170	925
168	54.18	36.12	978	172	940
170	55.04	36.69	993	174	956
172	55.93	37.29	1009	176	972
174	56.86	37.91	1026	178	988
176	57.83	38.55	1043	180	1006
178	58.83	39.22	1062	182	1024
180	59.88	39.92	1080	184	1043
182	60.96	40.64	1100	186	1062
184	62.10	41.40	1121	188	1083
186	63.28	42.18	1142	190	1104
188	64.50	43.00	1164	192	1126
190	65.78	43.85	1187	194	1149
192	67.11	44.74	1211	196	1173
194	68.50	45.66	1236	198	1198
196	69.94	46.62	1262	200	1224
198	71.44	47.62	1289	202	1251
200	73.00	48.66	1317	204	1280
202	74.62	49.75	1346	206	1309
204	76.31	50.87	1377	208	1339
206	78.07	52.05	1409	210	1371
208	79.90	53.27	1442	212	1404
210	81.81	54.54	1476	214	1438
212	83.79	55.86	1512	216	1474
214	85.86	57.24	1549	218	1512
216	88.00	58.67	1588	220	1550
218	90.24	60.16	1628	222	1591
220	92.57	61.71	1670	224	1633
222	94.99	63.33	1714	226	1676
224	97.51	65.01	1760	228	1722
226	100.14	66.76	1807	230	1769
228	102.87	68.58	1856	232	1819
230	105.71	70.48	1908	234	1870
232	108.67	72.45	1961	236	1923

Table 8: NMP1 Normal Operation – Core Not Critical (Curve B), Beltline Region, 46 EFPY

Plant =	NMP1		
Component =	Beltline		
Vessel thickness, t =	7.125	inches	
Vessel Radius, R =	106.5	inches	
ART =	167.4	°F =====>	46 EFPY
K_{It} =	12.91	ksi??in	
Safety Factor =	2.0		
M_m =	2.472		
Temperature Adjustment =	12.2	°F (instrument uncertainty)	
Pressure Adjustment =	27.7	psig (hydrostatic pressure head for a full vessel at 70 °F)	
Pressure Adjustment =	52.2	psig (instrument uncertainty)	
Heat Up and Cool Down Rate =	100	°F/Hr	

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
48	35.10	11.09	300	70	0
48	35.10	11.09	300	70	220
50	35.18	11.13	301	70	221
52	35.26	11.17	302	70	223
54	35.35	11.22	304	70	224
56	35.43	11.26	305	70	225
58	35.53	11.31	306	70	226
60	35.62	11.35	307	72	227
62	35.72	11.40	309	74	229
64	35.82	11.45	310	76	230
66	35.93	11.51	311	78	232
68	36.04	11.56	313	80	233
70	36.16	11.62	315	82	235
72	36.28	11.68	316	84	236
74	36.40	11.74	318	86	238
76	36.53	11.81	320	88	240
78	36.67	11.88	321	90	242
80	36.81	11.95	323	92	244
82	36.96	12.02	325	94	246
84	37.11	12.10	327	96	248
86	37.27	12.18	330	98	250
88	37.44	12.26	332	100	252
90	37.61	12.35	334	102	254
92	37.79	12.44	337	104	257
94	37.98	12.53	339	106	259
96	38.17	12.63	342	108	262
98	38.37	12.73	345	110	265
100	38.59	12.84	347	112	268
102	38.81	12.95	350	114	271
104	39.03	13.06	353	116	274
106	39.27	13.18	357	118	277
108	39.52	13.30	360	120	280
110	39.78	13.43	364	122	284
112	40.05	13.57	367	124	287
114	40.33	13.71	371	126	291
116	40.62	13.85	375	128	295
118	40.92	14.00	379	130	299
120	41.23	14.16	383	132	303
122	41.56	14.32	388	134	308
124	41.90	14.50	392	136	312
126	42.26	14.67	397	138	317
128	42.63	14.86	402	140	322
130	43.01	15.05	407	142	327
132	43.41	15.25	413	144	333
134	43.83	15.46	418	146	339
136	44.26	15.68	424	148	344
138	44.72	15.90	430	150	351
140	45.19	16.14	437	152	357

Table 8 (Continued)

Gauge Fluid Temperature (°F)	K_{Ic} (ksi-√in)	K_{Im} (ksi-√in)	Gauge Pressure (psig)	Temperature for P-T Curve (°F)	Adjusted Pressure for P-T Curve (psig)
142	45.68	16.38	443	154	364
144	46.18	16.64	450	156	370
146	46.71	16.90	457	158	378
148	47.27	17.18	465	160	385
150	47.84	17.46	473	162	393
152	48.44	17.76	481	164	401
154	49.06	18.07	489	166	409
156	49.71	18.40	498	168	418
158	50.38	18.73	507	170	427
160	51.08	19.08	517	172	437
162	51.81	19.45	526	174	447
164	52.57	19.83	537	176	457
166	53.36	20.22	547	178	468
168	54.18	20.64	559	180	479
170	55.04	21.06	570	182	490
172	55.93	21.51	582	184	502
174	56.86	21.97	595	186	515
176	57.83	22.46	608	188	528
178	58.83	22.96	621	190	542
180	59.88	23.48	636	192	556
182	60.96	24.03	650	194	570
184	62.10	24.59	666	196	586
186	63.28	25.18	682	198	602
188	64.50	25.80	698	200	618
190	65.78	26.43	715	202	636
192	67.11	27.10	733	204	654
194	68.50	27.79	752	206	672
196	69.94	28.51	772	208	692
198	71.44	29.26	792	210	712
200	73.00	30.04	813	212	733
202	74.62	30.85	835	214	755
204	76.31	31.70	858	216	778
206	78.07	32.58	882	218	802
208	79.90	33.49	907	220	827
210	81.81	34.45	932	222	852
212	83.79	35.44	959	224	879
214	85.86	36.47	987	226	907
216	88.00	37.55	1016	228	936
218	90.24	38.66	1046	230	967
220	92.57	39.83	1078	232	998
222	94.99	41.04	1111	234	1031
224	97.51	42.30	1145	236	1065
226	100.14	43.61	1180	238	1101
228	102.87	44.98	1217	240	1138
230	105.71	46.40	1256	242	1176
232	108.67	47.88	1296	244	1216
234	111.75	49.42	1338	246	1258
236	114.96	51.02	1381	248	1301
238	118.30	52.69	1426	250	1346
240	121.77	54.43	1473	252	1393
242	125.38	56.23	1522	254	1442
244	129.14	58.12	1573	256	1493
246	133.06	60.07	1626	258	1546
248	137.14	62.11	1681	260	1601
250	141.38	64.23	1739	262	1659
252	145.79	66.44	1798	264	1718
254	150.39	68.74	1860	266	1781
256	155.17	71.13	1925	268	1845
258	160.15	73.62	1993	270	1913

Table 9: NMP1 Normal Operation – Core Critical (Curve C), 46 EFPY

Plant =	NMP1	
Curve A Leak Test Temperature =	185.2	°F
Curve A Leak Test Pressure =	1,055	psig
Unit Pressure =	1,875	psig (hydrostatic pressure)
Flange RT_{NDT} =	40.0	°F

Adjusted P-T Curve Temperature (°F)	Adjusted P-T Curve Pressure (psig)
100	0
100	113
102	119
104	122
106	126
108	131
110	136
112	141
114	147
116	153
118	159
120	165
122	172
124	179
126	186
128	194
130	202
132	210
134	219
136	228
138	238
140	248
142	254
144	257
146	259
148	262
150	265
152	268
154	271
156	274
158	277
160	280
162	284
164	287
166	291
168	295
170	299
172	303
174	308
176	312
178	317
180	322
182	327
184	333
186	339
188	344
190	351
192	357
194	364
196	370
198	375
200	375

Table 9 (Continued)

Adjusted P-T Curve Temperature (°F)	Adjusted P-T Curve Pressure (psig)
200	385
202	393
204	401
206	409
208	418
210	427
212	437
214	447
216	457
218	468
220	479
222	490
224	502
226	515
228	528
230	542
232	556
234	570
236	586
238	602
240	618
242	636
244	654
246	672
248	692
250	712
252	733
254	755
256	778
258	802
260	827
262	852
264	879
266	907
268	936
270	967
272	998
274	1031
276	1065
278	1101
280	1138
282	1176
284	1216
286	1258
288	1301
290	1346
292	1393
294	1442
296	1493
298	1546
300	1601
302	1659
304	1718
306	1781
308	1845
310	1913

Table 10: NMP1 ART Calculations for 28 EFPY

	Description	Code No.	Heat No.	Flux Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments for 1/4T			
									ΔRT_{NDT}	Margin Terms		ART_{NDT}
						Cu (wt%)	Ni (wt%)		(°F)	σ_i (°F)	σ_Δ (°F)	(°F)
Plates	Upper Shell Plate	G-307-3	P2074	-	28	0.2	0.48	134.6	57.7	0	17	119.7
	Upper Shell Plate	G-307-4	P2076	-	40	0.27	0.53	173.85	74.6	0	17	148.6
	Upper Shell Plate	G-307-10	P2091	-	20	0.22	0.51	148.85	63.8	0	17	117.8
	Lower Shell Plate	G-8-1	P2112	-	36	0.236	0.503	228.35	81.4	0	17	151.4
	Lower Shell Plate	G-8-3/4	P2130A	-	-3	0.176	0.586	146.8	52.3	0	8.5	66.3
Welds	Upper Shell Axial Welds	2-564A/C	86054B	4E5F	-50	0.214	0.046	97.59	41.4	0	20.7	32.8
	Lower Shell Axial Welds	2-564D/F	86054B	4E5F	-50	0.214	0.046	97.59	34.6	0	17.3	19.3
	Circumferential Weld Seam	3-564	1248	4M2F	-50	0.214	0.076	99.9	35.6	0	17.8	21.2

Fluence Data

	Location		Wall Thickness (in)		Fluence at ID (n/cm^2)	Attenuation	Fluence at 1/4 T, f (n/cm^2)	Fluence Factor, FF
			Full	1/4 T		1/4T = e-0.24x		f(0.28-0.10log f)
Plates	Upper Shell Plate	G-307-3	7.125	1.781	1.63E+18	0.652	1.06E+18	0.429
	Upper Shell Plate	G-307-4	7.125	1.781	1.63E+18	0.652	1.06E+18	0.429
	Upper Shell Plate	G-307-10	7.125	1.781	1.63E+18	0.652	1.06E+18	0.429
	Lower Shell Plate	G-8-1	7.125	1.781	1.12E+18	0.652	7.29E+17	0.357
	Lower Shell Plate	G-8-3/4	7.125	1.781	1.12E+18	0.652	7.29E+17	0.357
Welds	Upper Shell Axial Welds	2-564A/C	7.125	1.781	1.59E+18	0.652	1.04E+18	0.424
	Lower Shell Axial Welds	2-564D/F	7.125	1.781	1.11E+18	0.652	7.22E+17	0.355
	Circumferential Weld Seam	3-564	7.125	1.781	1.12E+18	0.652	7.29E+17	0.357

Table 11: NMP1 ART Calculations for 36 EFPY

	Description	Code No.	Heat No.	Flux Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments for 1/4T			
									ΔRT_{NDT}	Margin Terms		ART_{NDT}
						Cu (wt%)	Ni (wt%)		(°F)	σ_I (°F)	σ_Δ (°F)	(°F)
Plates	Upper Shell Plate	G-307-3	P2074	-	28	0.2	0.48	134.6	63.5	0	17	125.5
	Upper Shell Plate	G-307-4	P2076	-	40	0.27	0.53	173.85	82.0	0	17	156.0
	Upper Shell Plate	G-307-10	P2091	-	20	0.22	0.51	148.85	70.2	0	17	124.2
	Lower Shell Plate	G-8-1	P2112	-	36	0.236	0.503	228.35	89.0	0	17	159.0
	Lower Shell Plate	G-8-3/4	P2130A	-	-3	0.176	0.586	146.8	57.2	0	8.5	71.2
Welds	Upper Shell Axial Welds	2-564A/C	86054B	4E5F	-50	0.214	0.046	97.59	45.5	0	22.8	41.1
	Lower Shell Axial Welds	2-564D/F	86054B	4E5F	-50	0.214	0.046	97.59	37.9	0	19.0	25.8
	Circumferential Weld Seam	3-564	1248	4M2F	-50	0.214	0.076	99.9	38.9	0	19.5	27.9

Fluence Data

	Location		Wall Thickness (in)		Fluence at ID (n/cm^2)	Attenuation 1/4T = e-0.24x	Fluence at 1/4 T, f (n/cm^2)	Fluence Factor, FF f(0.28-0.10log f)
			Full	1/4 T				
Plates	Upper Shell Plate	G-307-3	7.125	1.781	2.00E+18	0.652	1.30E+18	0.472
	Upper Shell Plate	G-307-4	7.125	1.781	2.00E+18	0.652	1.30E+18	0.472
	Upper Shell Plate	G-307-10	7.125	1.781	2.00E+18	0.652	1.30E+18	0.472
	Lower Shell Plate	G-8-1	7.125	1.781	1.34E+18	0.652	8.71E+17	0.390
	Lower Shell Plate	G-8-3/4	7.125	1.781	1.34E+18	0.652	8.71E+17	0.390
Welds	Upper Shell Axial Welds	2-564A/C	7.125	1.781	1.95E+18	0.652	1.27E+18	0.467
	Lower Shell Axial Welds	2-564D/F	7.125	1.781	1.33E+18	0.652	8.65E+17	0.388
	Circumferential Weld Seam	3-564	7.125	1.781	1.34E+18	0.652	8.71E+17	0.390

Table 12: NMP1 ART Calculations for 46 EFPY

	Description	Code No.	Heat No.	Flux Lot No.	Initial RT_{NDT} (°F)	Chemistry		Chemistry Factor (°F)	Adjustments for 1/4T			
									ΔRT_{NDT}	Margin Terms		ART_{NDT}
						Cu (wt%)	Ni (wt%)		(°F)	σ_I (°F)	σ_Δ (°F)	(°F)
Plates	Upper Shell Plate	G-307-3	P2074	-	28	0.2	0.48	134.6	69.7	0	17	131.7
	Upper Shell Plate	G-307-4	P2076	-	40	0.27	0.53	173.85	90.0	0	17	164.0
	Upper Shell Plate	G-307-10	P2091	-	20	0.22	0.51	148.85	77.0	0	17	131.0
	Lower Shell Plate	G-8-1	P2112	-	36	0.236	0.503	228.35	97.4	0	17	167.4
	Lower Shell Plate	G-8-3/4	P2130A	-	-3	0.176	0.586	146.8	62.6	0	8.5	76.6
Welds	Upper Shell Axial Welds	2-564A/C	86054B	4E5F	-50	0.214	0.046	97.59	50.0	0	25.0	50.0
	Lower Shell Axial Welds	2-564D/F	86054B	4E5F	-50	0.214	0.046	97.59	41.5	0	20.8	33.0
	Circumferential Weld Seam	3-564	1248	4M2F	-50	0.214	0.076	99.9	42.6	0	21.3	35.2

Fluence Data

	Location		Wall Thickness (in)		Fluence at ID (n/cm^2)	Attenuation 1/4T = e-0.24x	Fluence at 1/4 T, f (n/cm^2)	Fluence Factor, FF f(0.28-0.10log f)
			Full	1/4 T				
Plates	Upper Shell Plate	G-307-3	7.125	1.781	2.46E+18	0.652	1.60E+18	0.518
	Upper Shell Plate	G-307-4	7.125	1.781	2.46E+18	0.652	1.60E+18	0.518
	Upper Shell Plate	G-307-10	7.125	1.781	2.46E+18	0.652	1.60E+18	0.518
	Lower Shell Plate	G-8-1	7.125	1.781	1.61E+18	0.652	1.05E+18	0.427
	Lower Shell Plate	G-8-3/4	7.125	1.781	1.61E+18	0.652	1.05E+18	0.427
Welds	Upper Shell Axial Welds	2-564A/C	7.125	1.781	2.40E+18	0.652	1.56E+18	0.512
	Lower Shell Axial Welds	2-564D/F	7.125	1.781	1.60E+18	0.652	1.04E+18	0.425
	Circumferential Weld Seam	3-564	7.125	1.781	1.61E+18	0.652	1.05E+18	0.427

Table 13: Heat Transfer Coefficients for NMP1 Feedwater Nozzle

0% Flow Case		
Region	Temperature (°F)	Heat Transfer Coefficient (Btu/hr-ft^2-°F)
1	550.0	205.1
2	550.0	205.1
3	550.0	205.1
4	550.0	205.1

100% Flow Case		
Region	Temperature (°F)	Heat Transfer Coefficient (Btu/hr-ft^2-°F)
1	100.0	2108.8
2	325.0	673.9
3	325.0	191.8
4	550.0	1000.0

Table 14: Feedwater Nozzle Material Properties

Material Properties

All Steels:	*Poisson's Ratio*	0.3
	Density	0.283

Reactor Vessel Plate (SA 302 Gr.B) [5, Material Group D]

T	*α*	*E*	*Thermal Conductivity, K*	*Thermal Diffusivity*	*Specific Heat, Cp*
F	*in/in*F*	*psi*	*BTU/hr*ft*F*	*ft²/hr*	*BTU/lb*F*
300	7.74E-06	2.80E+07	24.7	0.42	0.12
350	7.88E-06		24.7	0.409	0.123
400	8.01E-06	2.74E+07	24.6	0.398	0.126
325	**7.81E-06**	**2.79E+07**	**24.7**	**0.4145**	**0.1215**

Nozzle Forging (SA 336 with Code Case 1236-1) [5, Material Group A]

T	*α*	*E*	*Thermal Conductivity, K*	*Thermal Diffusivity*	*Specific Heat, Cp*
F	*in/in*F*	*psi*	*BTU/hr*ft*F*	*ft2/hr*	*BTU/lb*F*
300	7.30E-06	2.85E+07	23.9	0.406	0.120
350	7.49E-06		23.7	0.396	0.122
400	7.66E-06	2.79E+07	23.6	0.385	0.125
325	**7.395E-06**	**2.84E+07**	**23.8**	**0.401**	**0.121**

Safe End (CS-I SA-105 Gr. II) [5, Material Group B]

T	*α*	*E*	*Thermal Conductivity, K*	*Thermal Diffusivity*	*Specific Heat, Cp*
F	*in/in*F*	*psi*	*BTU/hr*ft*F*	*ft²/hr*	*BTU/lb*F*
300	7.18E-06	2.81E+07	28.4	0.481	0.1207
350	7.47E-06		28.0	0.464	0.1234
400		2.75E+07			
325	**7.325E-06**	**2.80E+07**	**28.2**	**0.4725**	**0.1221**

APPENDIX A

NMP1 REACTOR VESSEL MATERIALS SURVEILLANCE PROGRAM

NMP1 has replaced the original materials surveillance program with the BWRVIP Integrated Surveillance Program (ISP). This program meets the requirements of 10 CFR 50, Appendix H, for integrated surveillance programs, and has been approved by the NRC (see NMP1 License Amendment No. 184, Reference 6.18). The representative plate material from the ISP is not the same heat number as the target plate in the NMP1 vessel. Also, the representative weld material is not the same heat number as the target weld in the NMP1 vessel. However, there is one matching plate heat number (heat number P2130-2) in the Supplemental Surveillance Program (SSP). Irradiated data is available from SSP capsules A, B, D, G, E, and I (Reference 6.7). Under the ISP, there is one weld heat that is scheduled to be tested in 2017. Representative surveillance capsule materials for the NMP1 weld are contained in the Hatch Unit 2 surveillance capsule program. Under the Supplemental Surveillance Program (SSP), there are no additional representative capsule materials to be tested.