VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

January 4, 2001

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No.	01-020
NL&OS/GSS/ETS	R0
Docket Nos.	50-338
	50-339
License Nos.	NPF-4
	NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
PROPOSED TECHNICAL SPECIFICATIONS CHANGES
REACTOR COOLANT SYSTEM PRESSURE/TEMPERATURE LIMITS
LTOPS SETPOINTS, AND LTOPS ENABLE TEMPERATURES

A Technical Specification change request concerning the North Anna Units 1 and 2 RCS pressure/temperature (P/T) limits, low temperature overpressure protection system (LTOPS) setpoints, and LTOPS enable temperatures (T_{enable}) was submitted to the NRC on June 22, 2000 (Serial No. 00-306). The objective of the submittal was to justify continued use of the existing Technical Specification P/T limits, LTOPS setpoints, and T_{enable} values on the basis of a margin assessment. The margin assessment relied in part on an exemption to the requirements of 10 CFR 50 Appendix G to permit application of ASME Section XI Code Case N-640. N-640 supports use of the ASME Section XI Appendix A K_{Ic} fracture toughness curve (Figure A-4200-1), instead of the ASME Section XI Appendix G K_{Ia} curve (Figure G-2210-1) that was employed in the development of the existing Technical Specification P/T limits and LTOPS setpoints. During a November 7, 2000 teleconference, the NRC staff indicated that application of pressure and temperature measurement uncertainties to the proposed design basis P/T limits would be required in order for this exemption request to be granted. Therefore, it became necessary to supplement the June 22, 2000 submittal with an evaluation of the effects of incorporating pressure and temperature measurement uncertainties into the proposed design basis P/T limits.

As the supplemental evaluation in Attachment 1 demonstrates, the existing North Anna Units 1 and 2 Technical Specification LTOPS setpoints remain valid and conservative after application of pressure and temperature measurement uncertainties to the LTOPS design basis P/T limit curve. However, application of pressure and temperature measurement uncertainties to the proposed revised design basis P/T limits causes them to become more limiting than the existing Technical Specification P/T limits. Therefore, the proposed revised design basis P/T limits, including allowances for pressure and temperature measurement uncertainty, must be incorporated into the Technical

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Specifications and associated operating procedures. The revised proposed Technical Specifications changes are provided as a mark-up in Attachment 2 and a typed version in Attachment 3. These proposed Technical Specifications changes supersede those provided in our letter of June 22, 2000 in their entirety. With the exception of the assertion that the existing Technical Specification P/T limits conservatively bound the proposed revised design basis P/T limit curves, the discussion and conclusions of the June 22, 2000 submittal remain valid.

We have evaluated the revised proposed changes and have determined that they do not involve a significant hazards consideration as defined in 10 CFR 50.92. The basis for our determination that the changes do not involve a significant hazards consideration is provided in Attachment 4. We have also determined that operation with the proposed changes will not result in any significant increases in the amounts of effluents that may be released offsite and in any significant increases in individual or cumulative occupational radiation exposure. Therefore, the proposed amendment is eligible for categorical exclusion as set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment is needed in connection with the approval of the proposed changes.

As previously reported in our letter of June 22, 2000, the revised cumulative core burnup applicability limit of 17.2 EFPY for the North Anna Unit 1 P/T limits, LTOPS setpoints, and LTOPS enable temperature will be reached in May 2001. North Anna Unit 2 is predicted to reach the cumulative core burnup applicability limit for the Technical Specification P/T limits, LTOPS setpoints, and LTOPS enable temperature in September 2001. Therefore, we request approval of the proposed Technical Specification changes, associated bases, and exemption requests by March 15, 2001.

In addition to the revised Technical Specifications and the associated bases, this letter provides the requested backup information to support the heatup and cooldown curves in WCAP-15112, Rev. 1.

If you have any further questions or require additional information, please contact us.

Very truly yours,

William R. Matthews
Vice President Nuclear Operations

Attachments:

Attachment 1	Discussion of Change
Attachment 2	Mark-up of Units 1 and 2 Technical Specifications Changes
Attachment 3	Proposed Units 1 and 2 Technical Specifications Changes
Attachment 4.	Significant Hazards Consideration Determination
Attachment 5	Backup Information to Support Heatup and Cooldown Curves Documented in WCAP-15112, Rev. 1

Commitments made in this letter:

1. There are no commitments in this letter

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COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by William R. Matthews, who is Vice President - Nuclear Operations, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 4TH day of January, 2001.

My Commission Expires: May 31, 2002.

Vicki L. Hull
Notary Public

(SEAL)

Attachment 1

Discussion of Changes

North Anna Power Station
Units 1 and 2
Virginia Electric and Power Company
(Dominion)

1.0 Background

A Technical Specification change request concerning the North Anna Units 1 and 2 RCS pressure/temperature (P/T) limits and low temperature overpressure protection system (LTOPS) setpoints was submitted to the NRC on June 22, 2000 [1]. The objective of the submittal was to justify continued use of the existing Technical Specification P/T limits and LTOPS setpoints on the basis of a margin assessment. The margin assessment requires an exemption to the requirements of 10 CFR 50 Appendix G to permit application of ASME Section XI Code Case N-640 [2]. N-640 supports use of the ASME Section XI Appendix A K_{Ic} fracture toughness curve (Figure A-4200-1), instead of the ASME Section XI Appendix G K_{Ia} curve (Figure G-2210-1) that was employed in the development of the existing Technical Specification P/T limits and LTOPS setpoints [3] [4]. During a November 7, 2000 teleconference, NRC staff indicated that application of pressure and temperature measurement uncertainties to the proposed design basis P/T limits would be required in order for this exemption request to be granted. Therefore, it became necessary to supplement the Reference [1] submittal with an evaluation of the effects of incorporating pressure and temperature measurement uncertainties into the proposed design basis P/T limits.

As this evaluation demonstrates, the existing Technical Specification LTOPS setpoints remain conservative and valid to cumulative core burnups of 32.3 EFPY and 34.3 EFPY for North Anna Units 1 and 2, respectively, after application of margins to accommodate pressure and temperature measurement uncertainty and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline). However, the proposed revised design basis P/T limits must be incorporated into the Technical Specifications and supporting operating procedures.

2.0 Method of Analysis

The following procedure was used to develop the proposed revised North Anna Units 1 and 2 Technical Specification P/T limit curves, and to demonstrate the conservatism of the existing North Anna Units 1 and 2 Technical Specification LTOPS setpoints:

1. The proposed revised design basis P/T limit curves, including the LTOPS design basis P/T limit curve (i.e., the "steady state", "isothermal", or "0°F/hr cooldown" curve) [5] presented in Appendix A, were modified to account for pressure and temperature measurement uncertainty, and for the pressure difference between the point of measurement (RCS hot leg) and the point of interest (the reactor vessel beltline). The resulting proposed revised North Anna Units 1 and 2 Technical Specification P/T limit curves are presented in Appendix C.

2. The temperature-dependent pressurizer PORV lift setpoint pressure "overshoot" values determined in the design basis mass addition and heat addition accident analysis [3] [4] were subtracted from the modified LTOPS design basis P/T limit curve determined in Step 1.

3. The current Technical Specification PORV lift setpoint pressure was subtracted from the values determined in Step 2.

4. The margin between the existing Technical Specification PORV lift setpoint pressure and the temperature-dependent LTOPS setpoint pressure limit determined in Step 2 was verified to be positive at each temperature.

The results of the LTOPS margin assessment performed using this methodology are presented in Appendix B.

3.0 Design Inputs

3.1 Unadjusted Pressure/Temperature Limit Curves

The proposed revised North Anna Units 1 and 2 design basis P/T limit curves for normal operation were developed in WCAP-15112, Revision 1 [5], and are presented in Appendix A. The curves presented in Appendix A do not include margins for pressure and temperature measurement uncertainty, or for the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

3.2 Narrow Range RCS Pressure Measurement Uncertainty

The Channel Statistical Accuracy (CSA) for the Narrow Range RCS pressure measurement uncertainty has been calculated to be 4.248% of a 0 psig to 800 psig instrument span, for a total CSA of 34 psi. Narrow Range RCS pressure is measured in the RCS hot leg. The Narrow Range RCS pressure measurement channel feeds the logic for opening and closing the pressurizer PORV at conditions during which the LTOPS system is enabled.

3.3 Wide Range RCS Pressure Measurement Uncertainty

The Channel Statistical Accuracy (CSA) for the Wide Range RCS pressure measurement uncertainty has been calculated to be 2.336% of a 0 psig to 3000 psig instrument span, for a total CSA of 70 psi. Wide Range RCS pressure is measured in the RCS hot leg. The Wide Range RCS pressure measurement channel is used for confirming RCS pressure during normal operation heatup and cooldown.

3.4 Wide Range RCS Temperature Measurement Uncertainty

The Channel Statistical Accuracy (CSA) for the Wide Range RCS temperature measurement uncertainty has been calculated to be 1.93% of a 0°F to 700°F instrument span, for a total CSA of 13.5°F. Wide Range RCS temperature is measured in the RCS cold leg. The Wide Range RCS temperature measurement channel is used for confirming RCS temperature during normal operation heatup and cooldown, and as input to the comparator for the LTOPS enabling temperature.

3.5 Pressure Difference Between Hot Leg and Reactor Vessel Beltline

The pressure difference between the point of measurement (Narrow Range or Wide Range RCS pressure measured in the RCS hot leg) and the point of interest (reactor vessel beltline) has been determined using the RETRAN transient analysis code to be 10 psi. This difference is applied as a bias to measured RCS pressure, whether by the Narrow Range or Wide Range instrumentation, to simulate pressure measurement at the assumed flaw in the reactor vessel beltline.

3.6 North Anna Units 1 and 2 LTOPS PORV Lift Setpoints

The current North Anna Unit 1 Technical Specification LTOPS PORV lift setpoint is 395 psig for RCS cold leg temperatures less than 150°F, and 500 psig for RCS cold leg temperatures between 150°F and the Unit 1 LTOPS enabling temperature of 235°F [3] [4]. The current North Anna Unit 2 Technical Specification LTOPS PORV lift setpoint is 375 psig for RCS cold leg temperatures less than 130°F, and 415 psig for RCS cold leg temperatures between 130°F and the Unit 2 LTOPS enabling temperature of 270°F [3] [4].

3.7 LTOPS PORV Lift Setpoint "Overshoot" Values from Mass Addition Accident Analysis

The mass addition and heat addition accident analyses that support the current North Anna Units 1 and 2 Technical Specification LTOPS setpoints are described in References [3] and [4]. The PORV lift setpoint "overshoot" values determined in the accident analysis are presented in Appendix B. (See column labeled "PORV Setpoint Overshoot".) The maximum PORV lift setpoint overshoot is a function of the PORV lift setpoint and RCS temperature.

3.8 Discussion of Reactor Vessel Neutron Fluence Values

The table below presents reactor vessel neutron fluence values (E>1 MeV) developed in accordance with the NRC-approved Virginia Power Reactor Vessel Fluence Analysis Methodology Topical Report [8].

Summary of Fluence Values Used to Calculate North Anna Units 1 and 2 Limiting RT_{NDT} Values			
EFPY	**Peak Clad / Base Metal Fluence** (n/cm^2, E > 1.0 MeV)	**¼-T Fluence** (n/cm^2, E > 1.0 MeV)	**¾-T Fluence** (n/cm^2, E > 1.0 MeV)
Unit 1			
32.3 (EOL)	3.92×10^{19}	2.446×10^{19}	0.952×10^{19}
50.3 (EOLR)	5.90×10^{19}	3.681×10^{19}	1.433×10^{19}
Unit 2			
34.3 (EOL)	3.96×10^{19}	2.471×10^{19}	0.962×10^{19}
54.3 (EOLR)	5.91×10^{19}	3.687×10^{19}	1.435×10^{19}

During a November 7, 2000 teleconference, NRC staff noted that the fluence values used in RT_{NDT} and RT_{PTS} calculations [6] [7] were characterized as corresponding to the neutron fluence at the clad/base metal interface. This characterization raised the question of whether the fluence values were appropriate for use in RG 1.99 Revision 2 [9] RT_{NDT} calculations. Virginia Power committed to clarify this apparent discrepancy as part of our response to concerns related to the application of margin to accommodate pressure and temperature measurement uncertainties.

The heading for the second column indicates that the fluence values correspond to the calculated best-estimate neutron fluence at the clad/base metal interface. This heading reflects the language of 10 CFR 50.61, "Fracture Toughness Requirements for Protection against Pressurized Thermal Shock Events," which defines the "EOL Fluence" as "the best-estimate neutron fluence projected for a specific vessel beltline material at the clad-base-metal interface on the inside surface of the vessel . . . ". In reality, the fluence values presented in this table conservatively bound the calculated best-estimate neutron fluence at the clad/base metal interface, because the calculations performed in accordance with the Virginia Power reactor vessel fluence analysis methodology [8] did not take credit for the neutron fluence attenuation of the reactor vessel cladding. Therefore, the values presented in this table actually reflect the neutron fluence values at the wetted inner surface of the vessel, consistent with the definition of the surface fluence, f_{surf}, in Regulatory Guide (RG) 1.99 Revision 2 [9]. Because the fluence values determined in accordance with the Virginia Power reactor vessel fluence analysis methodology [8] characterize the fluence at the inner wetted surface of the vessel, the fluence values may be conservatively applied to either the inner wetted surface of the vessel (for RT_{NDT} calculations) or to the clad/base metal interface (for RT_{PTS} calculations).

The fluence attenuation equation in RG 1.99 Revision 2 [9] measures the depth into the vessel wall in inches, relative to the inner wetted surface of the vessel. The total thickness of the North Anna Units 1 and 2 reactor vessels, including cladding and base metal, is 7.862 inches. (The cladding thickness is approximately 0.16 inches, and the base metal thickness is approximately 7.705 inches [5].) Thus, the fluence attenuation for RT_{NDT} calculations are correctly based on a ¼-T location in the North Anna vessels at a distance 7.862 * 0.25 = 1.966 inches into the vessel from the wetted surface [6] [7]. References [6] and [7] demonstrate that ¼-T and ¾-T RT_{NDT} values of 218.5°F and 195.6°F assumed in the development of the proposed revised design and licensing basis P/T limit curves [5] are conservative.

4.0 Analysis

The results of calculations performed in accordance with the analysis methodology outlined above are presented in Appendix B. As Appendix B demonstrates, the currently applicable North Anna Units 1 and 2 Technical Specification LTOPS setpoints continue to provide bounding protection for 100% of the proposed revised design basis isothermal P/T limit curve under postulated mass addition and heat addition accident conditions. The analysis includes consideration of pressure and temperature measurement uncertainties, as well as the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline). Because the proposed revised design basis P/T limit curves are based on a ¼-T RT_{NDT} value of 218.5°F, which conservatively bounds the most limiting ¼-T RT_{NDT} value at cumulative core burnups of 32.3 EFPY and 34.3 EFPY for North Anna Units 1 and 2 (as documented in References [6] and [7]), the existing North Anna Units 1 and 2 LTOPS setpoints are concluded to remain conservative for North Anna Units 1 and 2 cumulative core burnups up to 32.3 EFPY and 34.3 EFPY. The proposed revised North Anna Units 1 and 2 Technical Specification P/T limit curves, which include allowances for pressure and temperature measurement uncertainty and for pressure measurement location bias, are similarly concluded to be conservative for North Anna Units 1 and 2 cumulative core burnups up to 32.3 EFPY and 34.3 EFPY.

5.0 Changes to North Anna Units 1 and 2 Technical Specifications

Based on the foregoing analysis and the analysis presented in Reference [1], it is concluded that no changes to the existing North Anna Units 1 and 2 Technical Specification LTOPS setpoints or LTOPS enable temperatures are required. However, the proposed revised design basis P/T limit curves presented in Appendix C must be incorporated into the Technical Specifications and into supporting operating procedures. These curves include margins to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

6.0 Affected UFSAR Sections

Sections of the North Anna Units 1 and 2 UFSAR will need to be revised to support implementation of the revised design basis analyses described herein. A UFSAR revision will be made in accordance with the requirements of 10 CFR 50.71(e).

7.0 Conclusions

Changes to North Anna Units 1 and 2 Technical Specification P/T limits, and to the analysis bases for the Technical Specification LTOPS setpoints and T_{enable} values are proposed. These changes include:

1. Replacement of the current North Anna Units 1 and 2 Technical Specification P/T limits, including the isothermal (steady-state) P/T limit curve that constitutes the design limit for the LTOPS setpoint analysis, with those documented in Appendix C. The Appendix C curves have been modified to account for RCS pressure and temperature measurement uncertainty, and for the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

2. Replacement of the current design and licensing basis RT_{NDT} calculations, and the associated relationship of cumulative core burnup to reactor vessel neutron fluence, with those previously submitted in References [6] and [7], and

3. Modification of the analysis basis for the Technical Specification LTOPS T_{enable} values with a plant-specific implementation of the analysis methodology that supports ASME Section XI Code Case N-514 [10].

Implementation of these proposed revised analysis bases requires:

1. An exemption from the requirements of 10 CFR 50 Appendix G to permit application of ASME Section XI Code Case N-640 [2] to North Anna Units 1 and 2, and

2. An exemption from the requirements of 10 CFR 50 Appendix G to permit plant-specific application of the analysis methodology that supports ASME Section XI Code Case N-514 [10] to North Anna Units 1 and 2.

After consideration of the information provided herein, and in the Reference [1] submittal, the following conclusions are made:

1. The existing North Anna Units 1 and 2 Technical Specification LTOPS setpoints, enabling temperatures, and component operability requirements ensure that the RCS pressure during design basis low temperature mass and heat addition transients will not exceed the proposed revised LTOPS design basis P/T limit curve.

2. The proposed revised Technical Specification P/T limits ensure that the design basis reactor vessel flaw will not propagate under conditions of normal operation for heatup rates up to 60°F/hr, and for cooldown rates up to 100°F/hr.

These conclusions remain valid for cumulative core burnups up to 32.3 EFPY and 34.3 EFPY for North Anna Units 1 and 2, respectively.

8.0 References

[1] Letter from D. A. Christian to USNRC, "Virginia Electric and Power Company, North Anna Power Station Units 1 and 2, Proposed Technical Specifications Changes, Requests for Exemptions Per 10 CFR 50.60(b), Reactor Coolant System Pressure/Temperature Limits, LTOPS Setpoints, and LTOPS Enable Temperatures," Serial No. 00-306, dated June 22, 2000.

[2] ASME Code Section XI, Code Case N-640, "Revision to Appendix G – Use of K_{1c}," Approved by Section XI and Main Committee, Published in May 1999, and included in the 1999 Addenda. (Per teleconference with J. R. Pfefferle of Wisconsin Electric and Power Company and ASME Section XI.)

[3] Letter from J. P. O'Hanlon (Virginia Power) to USNRC, "Virginia Electric and Power Company, North Anna Power Station Units 1 and 2, Proposed Technical Specifications Change," dated April 15, 1994 (Virginia Power Serial No. 94-238).

[4] Letter from L. B. Engle (USNRC) to J. P. O'Hanlon, "North Anna Units 1 and 2 – Issuance of Amendments Re: Pressure/Temperature Operating Limits/Low Temperature Overpressure Protection System Pressure Setpoints/Limiting Conditions for Operation, Action Statements, and Surveillance Requirements for PORVs and Block Valves to Address Generic Letter 90-06 (TAC Nos. M77363, M77364, M77433, M77434, M89312, and M89313)," dated October 5, 1994 (Virginia Power Serial No. 94-607).

[5] WCAP-15112, Revision 1, "North Anna Units 1 and 2 WOG Reactor Vessel 60-Year Evaluation Minigroup Heatup and Cooldown Limit Curves for Normal Operation," dated October, 1998.

[6] Letter from L. N. Hartz to USNRC, "Virginia Electric and Power Company, North Anna Power Station Units 1 and 2, Surry Power Station Units 1 and 2, Evaluation of Reactor Vessel Materials Surveillance Data," dated November 19, 1999 (Virginia Power Serial No. 99-452A).

[7] Letter from L. N. Hartz to USNRC, "Virginia Electric and Power Company, North Anna Power Station Unit 2, Evaluation of Reactor Vessel Materials Surveillance Data," dated September 19, 2000 (Virginia Power Serial No. 00-463).

[8] Letter from N. Kalyanam (USNRC) to J. P. O'Hanlon (Virginia Power), "North Anna Power Station, Units 1 and 2, and Surry Power Station, Units 1 and 2 – Reactor Vessel Fluence Analysis Methodology (Generic Letter 92-01, Revision 1, Supplement 1) (TAC Nos. MA0555, MA0556, MA0576, and MA0577)," dated April 13, 1999 (Virginia Power Serial No. 99-242; NRC Safety Evaluation Report for Virginia Power Topical Report VEP-NAF-3, "Reactor Vessel Fluence Analysis Methodology," dated November, 1997).

[9] Regulatory Guide 1.99 Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," dated May 1988.

[10] ASME Code Section XI, Code Case N-514, "Low Temperature Overpressure Protection."

Appendix A

North Anna Units 1 and 2 P/T Limit Curves (WCAP-15112 Revision 1, Unmodified)

Table 1	North Anna Units 1 and 2 Heatup Data with Margins of 0 Degrees F and 0 psi for Instrumentation Errors (WCAP-15112 Rev. 1)

Heatup Rate = 20 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	621.00
2	65	621.00
3	85	621.00
4	90	621.00
5	95	621.00
6	98	621.00
7	98	664.43
8	100	665.83
9	105	669.69
10	110	673.96
11	115	678.68
12	120	683.89
13	125	689.65
14	130	696.02
15	135	703.06
16	140	710.84
17	145	719.44
18	150	728.94
19	155	739.44
20	160	751.05
21	165	763.88
22	170	778.05
23	175	793.72
24	180	811.03
25	185	830.17
26	190	851.31
27	195	874.68
28	200	900.51
29	205	929.06
30	210	960.61
31	215	995.47
32	220	1034.00
33	225	1076.59
34	230	1123.65
35	235	1175.67
36	240	1233.15
37	245	1296.68
38	250	1366.89
39	255	1444.48
40	260	1530.24
41	265	1625.01
42	270	1729.76
43	275	1845.51
44	280	1973.45
45	285	2114.83
46	290	2265.93
47	295	2430.07

Heatup Rate = 40 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	621.00
2	65	621.00
3	85	621.00
4	90	621.00
5	95	621.00
6	98	621.00
7	98	640.24
8	100	640.24
9	105	641.91
10	110	644.78
11	115	648.80
12	120	653.74
13	125	659.64
14	130	666.39
15	135	674.09
16	140	682.72
17	145	692.38
18	150	703.12
19	155	715.07
20	160	728.30
21	165	742.98
22	170	759.22
23	175	777.19
24	180	797.06
25	185	819.05
26	190	843.34
27	195	870.19
28	200	899.86
29	205	929.06
30	210	960.61
31	215	995.47
32	220	1034.00
33	225	1076.59
34	230	1123.65
35	235	1175.67
36	240	1233.15
37	245	1296.68
38	250	1366.89
39	255	1444.48
40	260	1530.24
41	265	1624.33
42	270	1716.12
43	275	1817.42
44	280	1929.31
45	285	2052.82
46	290	2189.25
47	295	2339.85

Heatup Rate = 60 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	618.37
2	65	618.37
3	85	618.37
4	90	618.37
5	95	618.37
6	100	618.37
7	105	618.37
8	110	618.37
9	115	619.17
10	120	621.18
11	125	624.35
12	130	628.56
13	135	633.81
14	140	640.06
15	145	647.35
16	150	655.69
17	155	665.16
18	160	675.82
19	165	687.76
20	170	701.08
21	175	715.92
22	180	732.39
23	185	750.67
24	190	770.92
25	195	793.35
26	200	818.16
27	205	845.61
28	210	875.96
29	215	909.51
30	220	946.57
31	225	987.53
32	230	1032.76
33	235	1082.72
34	240	1137.90
35	245	1198.82
36	250	1266.08
37	255	1340.35
38	260	1422.32
39	265	1512.82
40	270	1612.71
41	275	1722.97
42	280	1844.66
43	285	1978.96
44	290	2123.44
45	295	2261.89
46	300	2414.77

Table 2	North Anna Units 1 and 2 Cooldown Data with Margins of 0 Degrees F and 0 psi for Instrumentation Errors (WCAP-15112 Rev. 1)

Cooldown Rate = 0 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	621.00
2	65	621.00
3	70	621.00
4	75	621.00
5	80	621.00
6	85	621.00
7	90	621.00
8	95	621.00
9	98	621.00
10	98	664.43
11	100	665.83
12	105	669.69
13	110	673.96
14	115	678.68
15	120	683.89
16	125	689.65
17	130	696.02
18	135	703.06
19	140	710.84
20	145	719.44
21	150	728.94
22	155	739.44
23	160	751.05
24	165	763.88
25	170	778.05
26	175	793.72
27	180	811.03
28	185	830.17
29	190	851.31
30	195	874.68
31	200	900.51
32	205	929.06
33	210	960.61
34	215	995.47
35	220	1034.00
36	225	1076.59
37	230	1123.65
38	235	1175.67
39	240	1233.15
40	245	1296.68
41	250	1366.89
42	255	1444.48
43	260	1530.24
44	265	1625.01
45	270	1729.76
46	275	1845.51
47	280	1973.45
48	285	2114.83
49	290	2271.09
50	295	2443.78

Cooldown Rate = 20 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	606.17
2	65	607.90
3	70	609.79
4	75	611.91
5	80	614.26
6	85	616.88
7	90	619.79
8	95	621.00
9	98	621.00
10	98	625.20
11	100	626.64
12	105	630.65
13	110	635.08
14	115	640.02
15	120	645.48
16	125	651.55
17	130	658.26
18	135	665.72
19	140	673.97
20	145	683.13
21	150	693.25
22	155	704.47
23	160	716.88
24	165	730.64
25	170	745.85
26	175	762.70
27	180	781.33
28	185	801.97
29	190	824.77
30	195	850.03
31	200	877.95
32	205	908.85
33	210	943.02
34	215	980.82
35	220	1022.61
36	225	1068.86
37	230	1119.98

Cooldown Rate = 40 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	566.07
2	65	567.72
3	70	569.60
4	75	571.72
5	80	574.09
6	85	576.76
7	90	579.75
8	95	583.09
9	100	586.82
10	105	590.99
11	110	595.63
12	115	600.81
13	120	606.57
14	125	612.99
15	130	620.11
16	135	628.03
17	140	636.82
18	145	646.59
19	150	657.42
20	155	669.45
21	160	682.77
22	165	697.56
23	170	713.94
24	175	732.11
25	180	752.22
26	185	774.52
27	190	799.19
28	195	826.54
29	200	856.80
30	205	890.32
31	210	927.41
32	215	968.48
33	220	1013.91
34	225	1064.22
35	230	1119.86

Table 2 (Cont'd)	North Anna Units 1 and 2 Cooldown Data with Margins of 0 Degrees F and 0 psi for Instrumentation Errors (WCAP-15112 Rev. 1)

Cooldown Rate = 60 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	525.14
2	65	526.77
3	70	528.64
4	75	530.78
5	80	533.20
6	85	535.93
7	90	539.01
8	95	542.48
9	100	546.37
10	105	550.73
11	110	555.61
12	115	561.08
13	120	567.17
14	125	573.98
15	130	581.56
16	135	590.02
17	140	599.42
18	145	609.89
19	150	621.52
20	155	634.45
21	160	648.80
22	165	664.75
23	170	682.44
24	175	702.08
25	180	723.85
26	185	748.00
27	190	774.77
28	195	804.44
29	200	837.32
30	205	873.76
31	210	914.11
32	215	958.82
33	220	1008.33
34	225	1063.16

Cooldown Rate = 100 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	60	440.84
2	65	442.46
3	70	444.38
4	75	446.60
5	80	449.15
6	85	452.08
7	90	455.42
8	95	459.22
9	100	463.52
10	105	468.39
11	110	473.88
12	115	480.05
13	120	486.98
14	125	494.76
15	130	503.47
16	135	513.21
17	140	524.09
18	145	536.24
19	150	549.78
20	155	564.89
21	160	581.70
22	165	600.41
23	170	621.22
24	175	644.37
25	180	670.08
26	185	698.65
27	190	730.36
28	195	765.58
29	200	804.65
30	205	848.01
31	210	896.10
32	215	949.44
33	220	1008.56
34	225	1074.11

Appendix B

North Anna Units 1 and 2 LTOPS Margin Assessment

Cooldown Rate = 0 Deg. F/hr
WCAP-15112 R1 (Modified)

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	577.00
2	78.5	577.00
3	83.5	577.00
4	88.5	577.00
5	93.5	577.00
6	98.5	577.00
7	103.5	577.00
8	108.5	577.00
9	111.5	577.00
10	111.5	620.43
11	113.5	621.83
12	118.5	625.69
13	123.5	629.96
14	128.5	634.68
15	133.5	639.89
16	138.5	645.65
17	143.5	652.02
18	148.5	659.06
19	153.5	666.84
20	158.5	675.44
21	163.5	684.94
22	168.5	695.44
23	173.5	707.05
24	178.5	719.88
25	183.5	734.05
26	188.5	749.72
27	193.5	767.03
28	198.5	786.17
29	203.5	807.31
30	208.5	830.68
31	213.5	856.51
32	218.5	885.06
33	223.5	916.61
34	228.5	951.47
35	233.5	990.00
36	238.5	1032.59
37	243.5	1079.65
38	248.5	1131.67
39	253.5	1189.15
40	258.5	1252.68
41	263.5	1322.89
42	268.5	1400.48
43	273.5	1486.24
44	278.5	1581.01
45	283.5	1685.76
46	288.5	1801.51
47	293.5	1929.45
48	298.5	2070.83
49	303.5	2227.09
50	308.5	2399.78

PORV Setpoint Overshoot

	Indicated Temperature (Deg. F)	Pressure (psi)
1	73.5	151.40
2	78.5	151.40
3	83.5	151.40
4	88.5	151.40
5	93.5	151.40
6	98.5	151.40
7	103.5	151.40
8	108.5	151.40
9	111.5	151.40
10	111.5	151.40
11	113.5	151.40
12	118.5	151.40
13	123.5	151.40
14	128.5	151.40
15	133.5	151.40
16	138.5	151.40
17	143.5	151.40
18	148.5	151.40
19	153.5	140.30
20	158.5	140.30
21	163.5	140.30
22	168.5	140.30
23	173.5	140.30
24	178.5	140.30
25	183.5	140.30
26	188.5	140.30
27	193.5	140.30
28	198.5	140.30
29	203.5	111.00
30	208.5	111.00
31	213.5	111.00
32	218.5	111.00
33	223.5	111.00
34	228.5	111.00
35	233.5	111.00
36	238.5	
37	243.5	
38	248.5	
39	253.5	
40	258.5	
41	263.5	
42	268.5	
43	273.5	
44	278.5	
45	283.5	
46	288.5	
47	293.5	
48	298.5	
49	303.5	
50	308.5	

0 deg. F/hr Curve minus
PORV Setpoint Overshoot

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	425.60
2	78.5	425.60
3	83.5	425.60
4	88.5	425.60
5	93.5	425.60
6	98.5	425.60
7	103.5	425.60
8	108.5	425.60
9	111.5	425.60
10	111.5	469.03
11	113.5	470.43
12	118.5	474.29
13	123.5	478.56
14	128.5	483.28
15	133.5	488.49
16	138.5	494.25
17	143.5	500.62
18	148.5	507.66
19	153.5	526.54
20	158.5	535.14
21	163.5	544.64
22	168.5	555.14
23	173.5	566.75
24	178.5	579.58
25	183.5	593.75
26	188.5	609.42
27	193.5	626.73
28	198.5	645.87
29	203.5	696.31
30	208.5	719.68
31	213.5	745.51
32	218.5	774.06
33	223.5	805.61
34	228.5	840.47
35	233.5	879.00
36	238.5	
37	243.5	
38	248.5	
39	253.5	
40	258.5	
41	263.5	
42	268.5	
43	273.5	
44	278.5	
45	283.5	
46	288.5	
47	293.5	
48	298.5	
49	303.5	
50	308.5	

[redacted]

	PORV Setpoint			Margin (Positive = Acceptable)		
	Indicated Temperature (Deg. F)	Indicated Pressure (psig)		Indicated Temperature (Deg. F)	Pressure (psig)	Minimum Margin (psig)
1	73.5	395	1	73.5	30.60	26.54
2	78.5	395	2	78.5	30.60	
3	83.5	395	3	83.5	30.60	
4	88.5	395	4	88.5	30.60	
5	93.5	395	5	93.5	30.60	
6	98.5	395	6	98.5	30.60	
7	103.5	395	7	103.5	30.60	
8	108.5	395	8	108.5	30.60	
9	111.5	395	9	111.5	30.60	
10	111.5	395	10	111.5	74.03	
11	113.5	395	11	113.5	75.43	
12	118.5	395	12	118.5	79.29	
13	123.5	395	13	123.5	83.56	
14	128.5	395	14	128.5	88.28	
15	133.5	395	15	133.5	93.49	
16	138.5	395	16	138.5	99.25	
17	143.5	395	17	143.5	105.62	
18	148.5	395	18	148.5	112.66	
19	153.5	500	19	153.5	26.54	
20	158.5	500	20	158.5	35.14	
21	163.5	500	21	163.5	44.64	
22	168.5	500	22	168.5	55.14	
23	173.5	500	23	173.5	66.75	
24	178.5	500	24	178.5	79.58	
25	183.5	500	25	183.5	93.75	
26	188.5	500	26	188.5	109.42	
27	193.5	500	27	193.5	126.73	
28	198.5	500	28	198.5	145.87	
29	203.5	500	29	203.5	196.31	
30	208.5	500	30	208.5	219.68	
31	213.5	500	31	213.5	245.51	
32	218.5	500	32	218.5	274.06	
33	223.5	500	33	223.5	305.61	
34	228.5	500	34	228.5	340.47	
35	233.5	500	35	233.5	379.00	
36	238.5	2250	36	238.5		
37	243.5	2250	37	243.5		
38	248.5	2250	38	248.5		
39	253.5	2250	39	253.5		
40	258.5	2250	40	258.5		
41	263.5	2250	41	263.5		
42	268.5	2250	42	268.5		
43	273.5	2250	43	273.5		
44	278.5	2250	44	278.5		
45	283.5	2250	45	283.5		
46	288.5	2250	46	288.5		
47	293.5	2250	47	293.5		
48	298.5	2250	48	298.5		
49	303.5	2250	49	303.5		
50	308.5	2250	50	308.5		

[redacted]

Cooldown Rate = 0 Deg. F/hr
WCAP-15112 R1 (Modified)

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	577.00
2	78.5	577.00
3	83.5	577.00
4	88.5	577.00
5	93.5	577.00
6	98.5	577.00
7	103.5	577.00
8	108.5	577.00
9	111.5	577.00
10	111.5	620.43
11	113.5	621.83
12	118.5	625.69
13	123.5	629.96
14	128.5	634.68
15	133.5	639.89
16	138.5	645.65
17	143.5	652.02
18	148.5	659.06
19	153.5	666.84
20	158.5	675.44
21	163.5	684.94
22	168.5	695.44
23	173.5	707.05
24	178.5	719.88
25	183.5	734.05
26	188.5	749.72
27	193.5	767.03
28	198.5	786.17
29	203.5	807.31
30	208.5	830.68
31	213.5	856.51
32	218.5	885.06
33	223.5	916.61
34	228.5	951.47
35	233.5	990.00
36	238.5	1032.59
37	243.5	1079.65
38	248.5	1131.67
39	253.5	1189.15
40	258.5	1252.68
41	263.5	1322.89
42	268.5	1400.48
43	273.5	1486.24
44	278.5	1581.01
45	283.5	1685.76
46	288.5	1801.51
47	293.5	1929.45
48	298.5	2070.83
49	303.5	2227.09
50	308.5	2399.78

PORV Setpoint Overshoot

	Indicated Temperature (Deg. F)	Pressure (psi)
1	73.5	151.40
2	78.5	151.40
3	83.5	151.40
4	88.5	151.40
5	93.5	151.40
6	98.5	151.40
7	103.5	151.40
8	108.5	151.40
9	111.5	151.40
10	111.5	151.40
11	113.5	151.40
12	118.5	151.40
13	123.5	151.40
14	128.5	151.40
15	133.5	151.40
16	138.5	151.40
17	143.5	151.40
18	148.5	151.40
19	153.5	140.30
20	158.5	140.30
21	163.5	140.30
22	168.5	140.30
23	173.5	140.30
24	178.5	140.30
25	183.5	140.30
26	188.5	140.30
27	193.5	140.30
28	198.5	140.30
29	203.5	111.00
30	208.5	111.00
31	213.5	111.00
32	218.5	111.00
33	223.5	111.00
34	228.5	111.00
35	233.5	111.00
36	238.5	111.00
37	243.5	111.00
38	248.5	111.00
39	253.5	81.40
40	258.5	81.40
41	263.5	81.40
42	268.5	81.40
43	273.5	
44	278.5	
45	283.5	
46	288.5	
47	293.5	
48	298.5	
49	303.5	
50	308.5	

0 deg. F/hr Curve minus
PORV Setpoint Overshoot

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	425.60
2	78.5	425.60
3	83.5	425.60
4	88.5	425.60
5	93.5	425.60
6	98.5	425.60
7	103.5	425.60
8	108.5	425.60
9	111.5	425.60
10	111.5	469.03
11	113.5	470.43
12	118.5	474.29
13	123.5	478.56
14	128.5	483.28
15	133.5	488.49
16	138.5	494.25
17	143.5	500.62
18	148.5	507.66
19	153.5	526.54
20	158.5	535.14
21	163.5	544.64
22	168.5	555.14
23	173.5	566.75
24	178.5	579.58
25	183.5	593.75
26	188.5	609.42
27	193.5	626.73
28	198.5	645.87
29	203.5	696.31
30	208.5	719.68
31	213.5	745.51
32	218.5	774.06
33	223.5	805.61
34	228.5	840.47
35	233.5	879.00
36	238.5	921.59
37	243.5	968.65
38	248.5	1020.67
39	253.5	1107.75
40	258.5	1171.28
41	263.5	1241.49
42	268.5	1319.08
43	273.5	
44	278.5	
45	283.5	
46	288.5	
47	293.5	
48	298.5	
49	303.5	
50	308.5	

[redacted]

	PORV Setpoint			Margin (Positive = Acceptable)		
	Indicated Temperature (Deg. F)	Indicated Pressure (psig)		Indicated Temperature (Deg. F)	Pressure (psig)	Minimum Margin (psig)
1	73.5	375	1	73.5	50.60	50.60
2	78.5	375	2	78.5	50.60	
3	83.5	375	3	83.5	50.60	
4	88.5	375	4	88.5	50.60	
5	93.5	375	5	93.5	50.60	
6	98.5	375	6	98.5	50.60	
7	103.5	375	7	103.5	50.60	
8	108.5	375	8	108.5	50.60	
9	111.5	375	9	111.5	50.60	
10	111.5	375	10	111.5	94.03	
11	113.5	375	11	113.5	95.43	
12	118.5	375	12	118.5	99.29	
13	123.5	375	13	123.5	103.56	
14	128.5	375	14	128.5	108.28	
15	133.5	415	15	133.5	73.49	
16	138.5	415	16	138.5	79.25	
17	143.5	415	17	143.5	85.62	
18	148.5	415	18	148.5	92.66	
19	153.5	415	19	153.5	111.54	
20	158.5	415	20	158.5	120.14	
21	163.5	415	21	163.5	129.64	
22	168.5	415	22	168.5	140.14	
23	173.5	415	23	173.5	151.75	
24	178.5	415	24	178.5	164.58	
25	183.5	415	25	183.5	178.75	
26	188.5	415	26	188.5	194.42	
27	193.5	415	27	193.5	211.73	
28	198.5	415	28	198.5	230.87	
29	203.5	415	29	203.5	281.31	
30	208.5	415	30	208.5	304.68	
31	213.5	415	31	213.5	330.51	
32	218.5	415	32	218.5	359.06	
33	223.5	415	33	223.5	390.61	
34	228.5	415	34	228.5	425.47	
35	233.5	415	35	233.5	464.00	
36	238.5	415	36	238.5	506.59	
37	243.5	415	37	243.5	553.65	
38	248.5	415	38	248.5	605.67	
39	253.5	415	39	253.5	692.75	
40	258.5	415	40	258.5	756.28	
41	263.5	415	41	263.5	826.49	
42	268.5	415	42	268.5	904.08	
43	273.5	2250	43	273.5		
44	278.5	2250	44	278.5		
45	283.5	2250	45	283.5		
46	288.5	2250	46	288.5		
47	293.5	2250	47	293.5		
48	298.5	2250	48	298.5		
49	303.5	2250	49	303.5		
50	308.5	2250	50	308.5		

[redacted]

Appendix C

Proposed North Anna Units 1 and 2 P/T Limits (WCAP-15112 Revision 1, Modified)

Table 1	North Anna Units 1 and 2 Heatup Data with Margins of 13.5 Degrees F and 70 psi for Instrumentation Errors (WCAP-15112 Rev. 1, Modified)

Heatup Rate = 20 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	540.90
2	78.5	540.90
3	98.5	540.90
4	103.5	540.90
5	108.5	540.90
6	111.5	540.90
7	111.5	584.33
8	113.5	585.73
9	118.5	589.59
10	123.5	593.86
11	128.5	598.58
12	133.5	603.79
13	138.5	609.55
14	143.5	615.92
15	148.5	622.96
16	153.5	630.74
17	158.5	639.34
18	163.5	648.84
19	168.5	659.34
20	173.5	670.95
21	178.5	683.78
22	183.5	697.95
23	188.5	713.62
24	193.5	730.93
25	198.5	750.07
26	203.5	771.21
27	208.5	794.58
28	213.5	820.41
29	218.5	848.96
30	223.5	880.51
31	228.5	915.37
32	233.5	953.90
33	238.5	996.49
34	243.5	1043.55
35	248.5	1095.57
36	253.5	1153.05
37	258.5	1216.58
38	263.5	1286.79
39	268.5	1364.38
40	273.5	1450.14
41	278.5	1544.91
42	283.5	1649.66
43	288.5	1765.41
44	293.5	1893.35
45	298.5	2034.73
46	303.5	2185.83
47	308.5	2349.97

Heatup Rate = 40 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	540.90
2	78.5	540.90
3	98.5	540.90
4	103.5	540.90
5	108.5	540.90
6	111.5	540.90
7	111.5	560.14
8	113.5	560.14
9	118.5	561.81
10	123.5	564.68
11	128.5	568.70
12	133.5	573.64
13	138.5	579.54
14	143.5	586.29
15	148.5	593.99
16	153.5	602.62
17	158.5	612.28
18	163.5	623.02
19	168.5	634.97
20	173.5	648.20
21	178.5	662.88
22	183.5	679.12
23	188.5	697.09
24	193.5	716.96
25	198.5	738.95
26	203.5	763.24
27	208.5	790.09
28	213.5	819.76
29	218.5	848.96
30	223.5	880.51
31	228.5	915.37
32	233.5	953.90
33	238.5	996.49
34	243.5	1043.55
35	248.5	1095.57
36	253.5	1153.05
37	258.5	1216.58
38	263.5	1286.79
39	268.5	1364.38
40	273.5	1450.14
41	278.5	1544.23
42	283.5	1636.02
43	288.5	1737.32
44	293.5	1849.21
45	298.5	1972.72
46	303.5	2109.15
47	308.5	2259.75

Heatup Rate = 60 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	538.27
2	78.5	538.27
3	98.5	538.27
4	103.5	538.27
5	108.5	538.27
6	113.5	538.27
7	118.5	538.27
8	123.5	538.27
9	128.5	539.07
10	133.5	541.08
11	138.5	544.25
12	143.5	548.46
13	148.5	553.71
14	153.5	559.96
15	158.5	567.25
16	163.5	575.59
17	168.5	585.06
18	173.5	595.72
19	178.5	607.66
20	183.5	620.98
21	188.5	635.82
22	193.5	652.29
23	198.5	670.57
24	203.5	690.82
25	208.5	713.25
26	213.5	738.06
27	218.5	765.51
28	223.5	795.86
29	228.5	829.41
30	233.5	866.47
31	238.5	907.43
32	243.5	952.66
33	248.5	1002.62
34	253.5	1057.80
35	258.5	1118.72
36	263.5	1185.98
37	268.5	1260.25
38	273.5	1342.22
39	278.5	1432.72
40	283.5	1532.61
41	288.5	1642.87
42	293.5	1764.56
43	298.5	1898.86
44	303.5	2043.34
45	308.5	2181.79
46	313.5	2334.67

Table 2	North Anna Units 1 and 2 Cooldown Data with Margins of 13.5 Degrees F and 70 psi for Instrumentation Errors (WCAP-15112 Rev. 1, Modified)

Cooldown Rate = 0 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	540.90
2	78.5	540.90
3	83.5	540.90
4	88.5	540.90
5	93.5	540.90
6	98.5	540.90
7	103.5	540.90
8	108.5	540.90
9	111.5	540.90
10	111.5	584.33
11	113.5	585.73
12	118.5	589.59
13	123.5	593.86
14	128.5	598.58
15	133.5	603.79
16	138.5	609.55
17	143.5	615.92
18	148.5	622.96
19	153.5	630.74
20	158.5	639.34
21	163.5	648.84
22	168.5	659.34
23	173.5	670.95
24	178.5	683.78
25	183.5	697.95
26	188.5	713.62
27	193.5	730.93
28	198.5	750.07
29	203.5	771.21
30	208.5	794.58
31	213.5	820.41
32	218.5	848.96
33	223.5	880.51
34	228.5	915.37
35	233.5	953.90
36	238.5	996.49
37	243.5	1043.55
38	248.5	1095.57
39	253.5	1153.05
40	258.5	1216.58
41	263.5	1286.79
42	268.5	1364.38
43	273.5	1450.14
44	278.5	1544.91
45	283.5	1649.66
46	288.5	1765.41
47	293.5	1893.35
48	298.5	2034.73
49	303.5	2190.99
50	308.5	2363.68

Cooldown Rate = 20 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	526.07
2	78.5	527.80
3	83.5	529.69
4	88.5	531.81
5	93.5	534.16
6	98.5	536.78
7	103.5	539.69
8	108.5	540.90
9	111.5	540.90
10	111.5	545.10
11	113.5	546.54
12	118.5	550.55
13	123.5	554.98
14	128.5	559.92
15	133.5	565.38
16	138.5	571.45
17	143.5	578.16
18	148.5	585.62
19	153.5	593.87
20	158.5	603.03
21	163.5	613.15
22	168.5	624.37
23	173.5	636.78
24	178.5	650.54
25	183.5	665.75
26	188.5	682.60
27	193.5	701.23
28	198.5	721.87
29	203.5	744.67
30	208.5	769.93
31	213.5	797.85
32	218.5	828.75
33	223.5	862.92
34	228.5	900.72
35	233.5	942.51
36	238.5	988.76
37	243.5	1039.88

Cooldown Rate = 40 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	485.97
2	78.5	487.62
3	83.5	489.50
4	88.5	491.62
5	93.5	493.99
6	98.5	496.66
7	103.5	499.65
8	108.5	502.99
9	113.5	506.72
10	118.5	510.89
11	123.5	515.53
12	128.5	520.71
13	133.5	526.47
14	138.5	532.89
15	143.5	540.01
16	148.5	547.93
17	153.5	556.72
18	158.5	566.49
19	163.5	577.32
20	168.5	589.35
21	173.5	602.67
22	178.5	617.46
23	183.5	633.84
24	188.5	652.01
25	193.5	672.12
26	198.5	694.42
27	203.5	719.09
28	208.5	746.44
29	213.5	776.70
30	218.5	810.22
31	223.5	847.31
32	228.5	888.38
33	233.5	933.81
34	238.5	984.12
35	243.5	1039.76

Table 2 (Cont'd)	North Anna Units 1 and 2 Cooldown Data with Margins of 13.5 Degrees F and 70 psi for Instrumentation Errors (WCAP-15112 Rev. 1, Modified)

Cooldown Rate = 60 Deg. F/hr

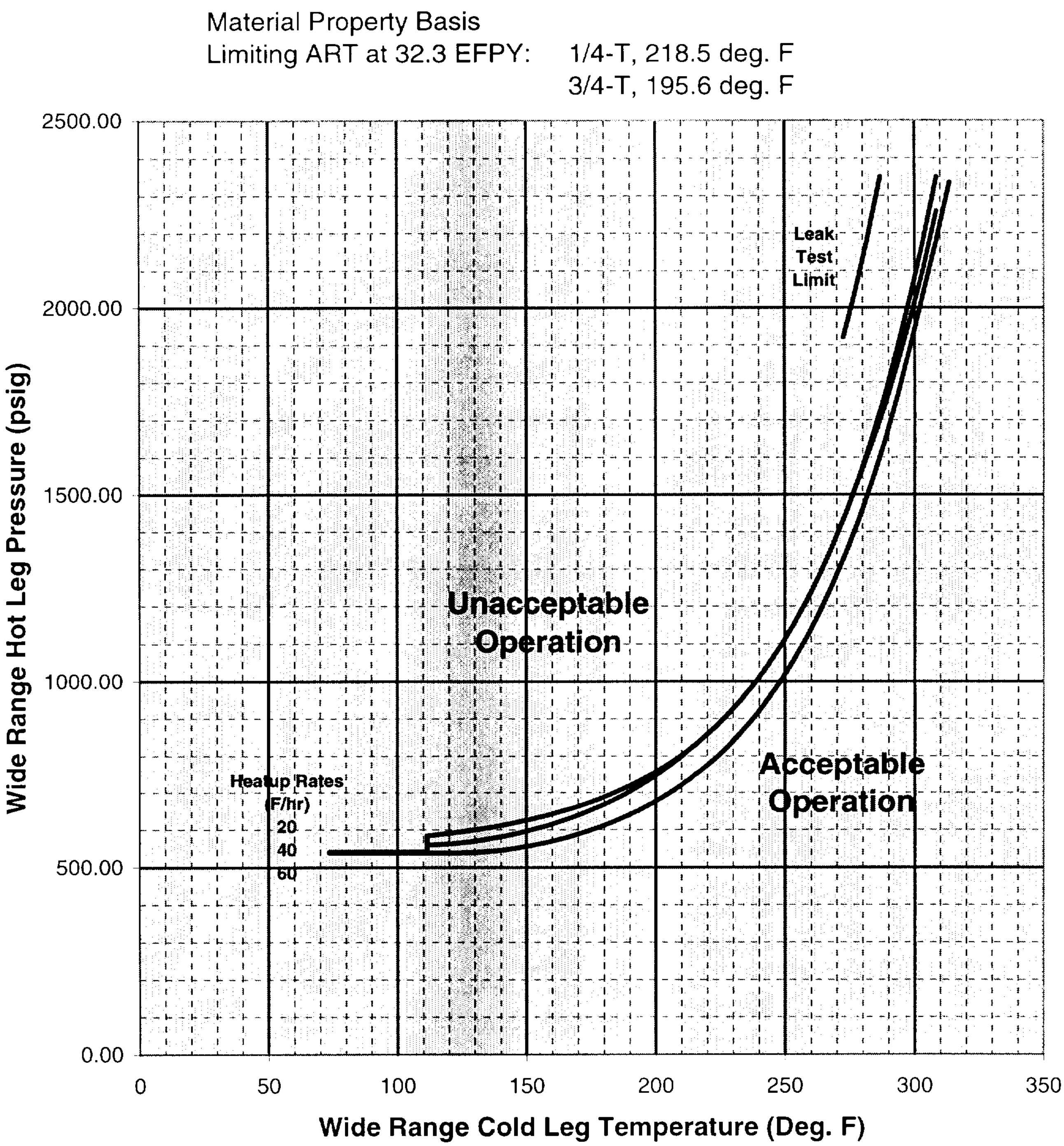
	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	445.04
2	78.5	446.67
3	83.5	448.54
4	88.5	450.68
5	93.5	453.10
6	98.5	455.83
7	103.5	458.91
8	108.5	462.38
9	113.5	466.27
10	118.5	470.63
11	123.5	475.51
12	128.5	480.98
13	133.5	487.07
14	138.5	493.88
15	143.5	501.46
16	148.5	509.92
17	153.5	519.32
18	158.5	529.79
19	163.5	541.42
20	168.5	554.35
21	173.5	568.70
22	178.5	584.65
23	183.5	602.34
24	188.5	621.98
25	193.5	643.75
26	198.5	667.90
27	203.5	694.67
28	208.5	724.34
29	213.5	757.22
30	218.5	793.66
31	223.5	834.01
32	228.5	878.72
33	233.5	928.23
34	238.5	983.06

Cooldown Rate = 100 Deg. F/hr

	Indicated Temperature (Deg. F)	Indicated Pressure (psig)
1	73.5	360.74
2	78.5	362.36
3	83.5	364.28
4	88.5	366.50
5	93.5	369.05
6	98.5	371.98
7	103.5	375.32
8	108.5	379.12
9	113.5	383.42
10	118.5	388.29
11	123.5	393.78
12	128.5	399.95
13	133.5	406.88
14	138.5	414.66
15	143.5	423.37
16	148.5	433.11
17	153.5	443.99
18	158.5	456.14
19	163.5	469.68
20	168.5	484.79
21	173.5	501.60
22	178.5	520.31
23	183.5	541.12
24	188.5	564.27
25	193.5	589.98
26	198.5	618.55
27	203.5	650.26
28	208.5	685.48
29	213.5	724.55
30	218.5	767.91
31	223.5	816.00
32	228.5	869.34
33	233.5	928.46
34	238.5	994.01

Figure 3.4-2

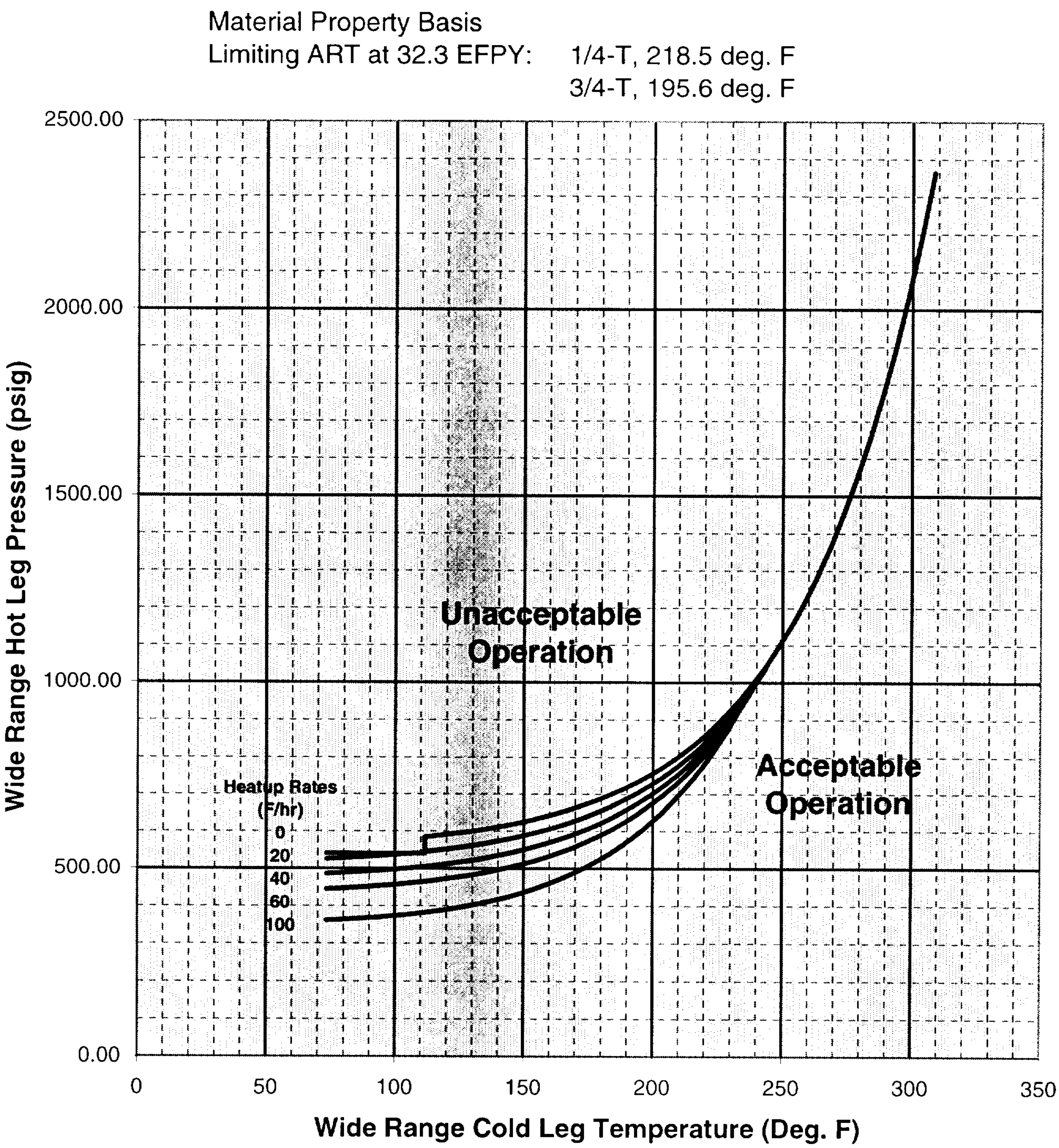
North Anna Unit 1
Reactor Coolant System Heatup Limitations



North Anna Unit 1 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr)
Applicable for the first 32.3 EFPY (Including Margins for Instrumentation Errors)

Figure 3.4-3

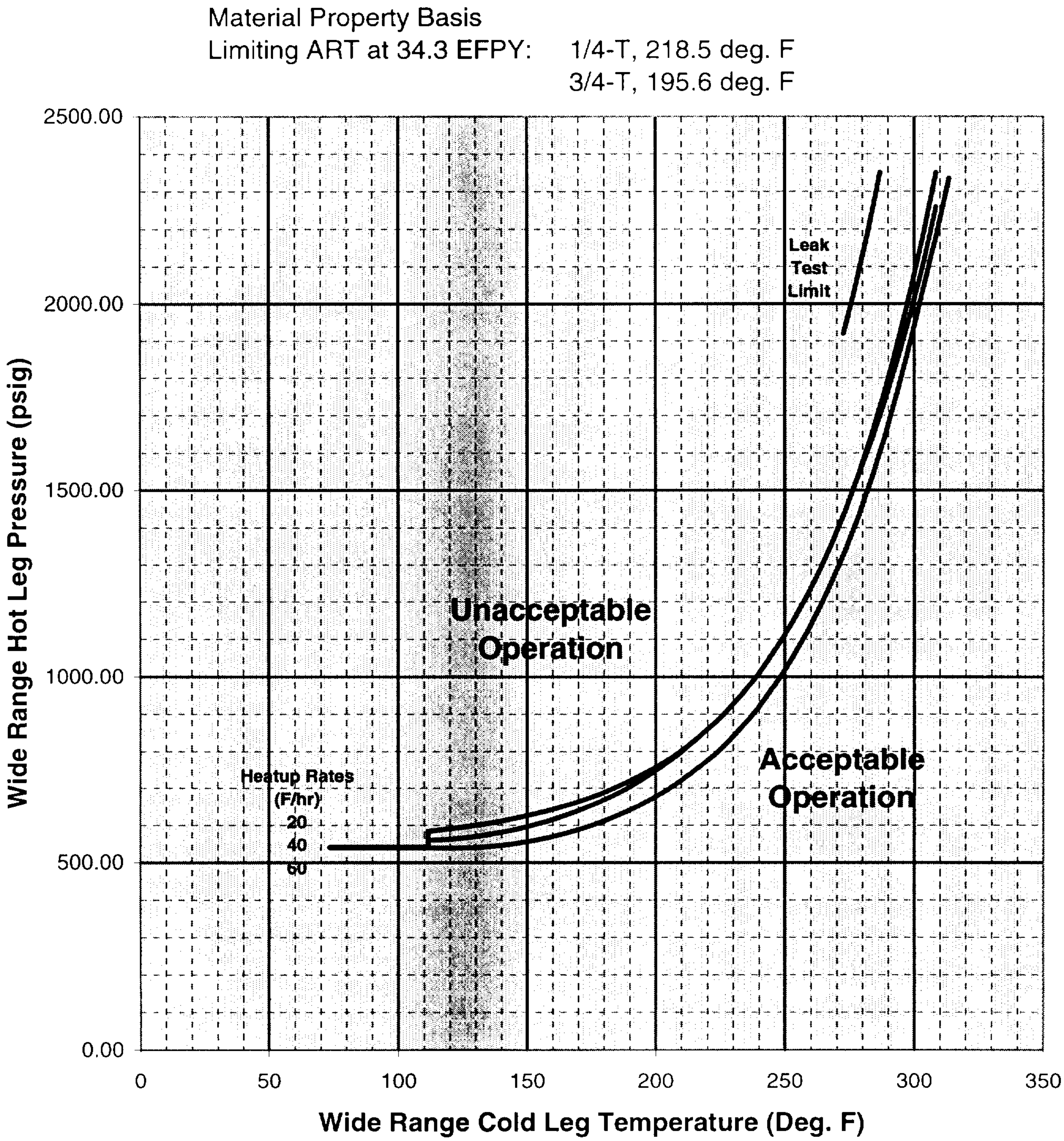
North Anna Unit 1
Reactor Coolant System Cooldown Limitations



North Anna Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr)
Applicable for the first 32.3 EFPY (Including Margins for Instrumentation Errors)

Figure 3.4-2

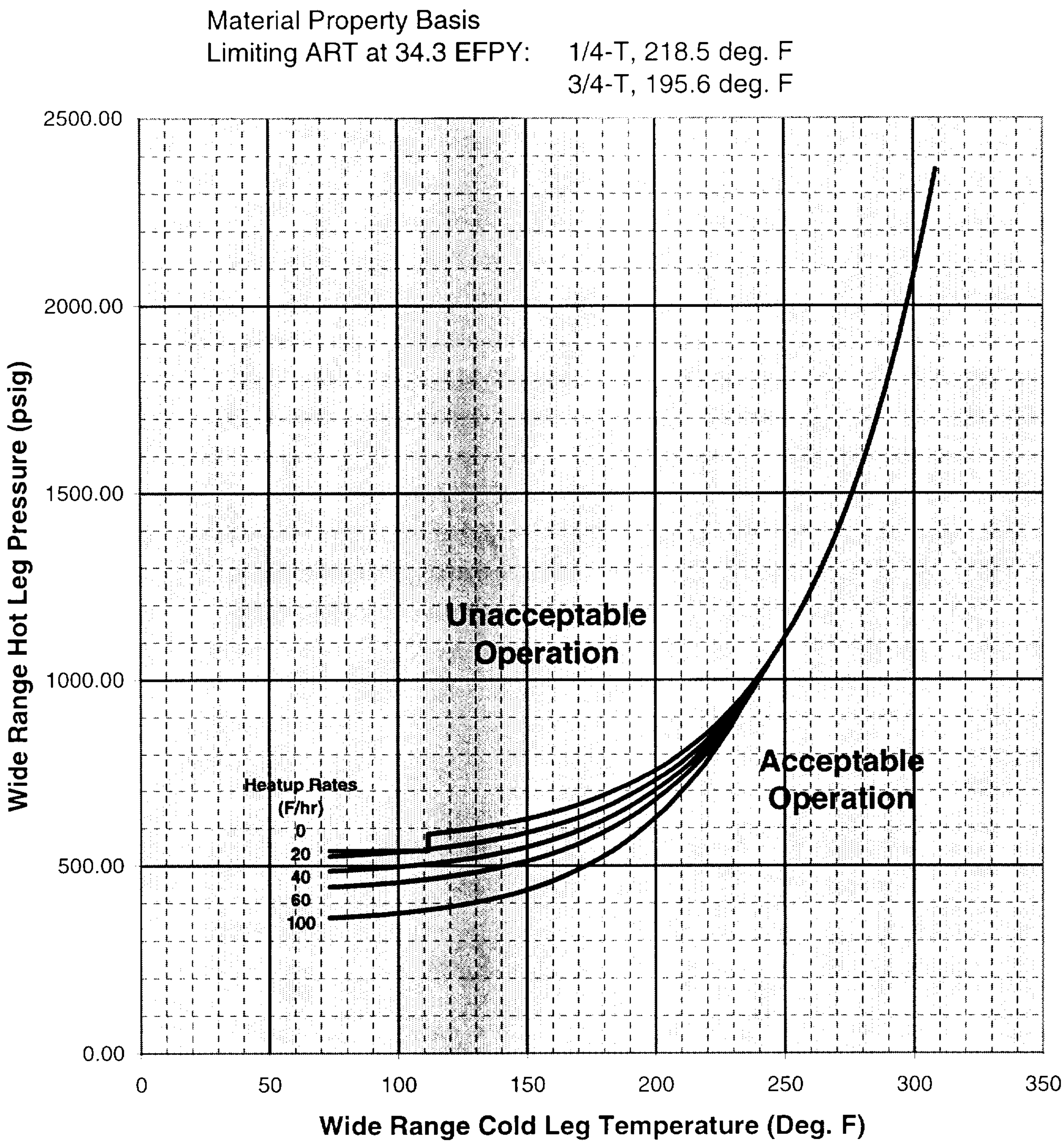
North Anna Unit 2
Reactor Coolant System Heatup Limitations



North Anna Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

Figure 3.4-3

North Anna Unit 2
Reactor Coolant System Cooldown Limitations



North Anna Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

Attachment 2

Mark-up of Unit 1 and Unit 2 Technical Specifications Changes

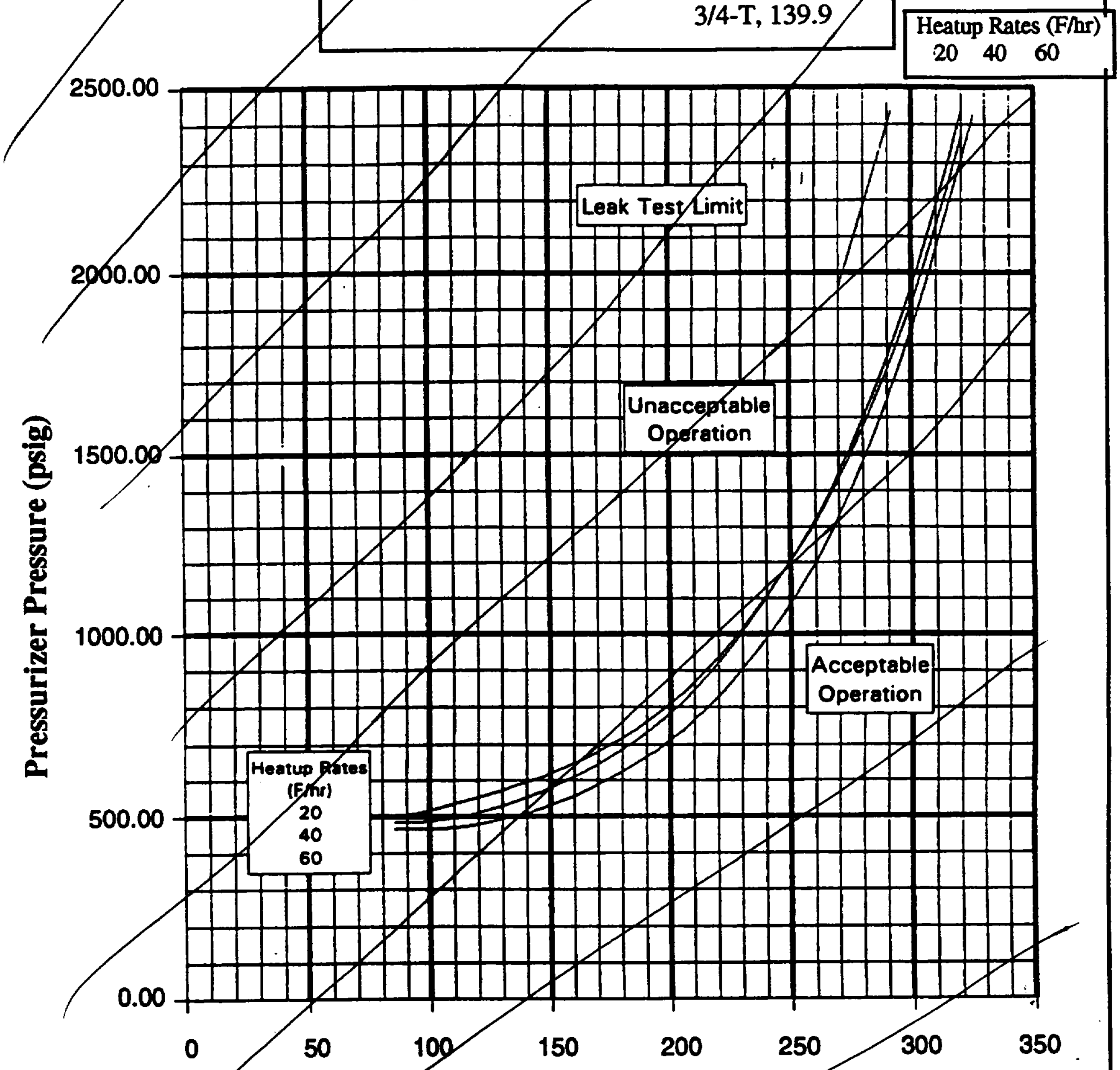
North North Anna Power Station
Units 1 and 2
Virginia Electric and Power Company
(Dominion)

Mark-up of Unit 1 Technical Specifications Changes

REPLACE WITH ATTACHED FIG 3.4-2

Figure 3.4-2 — **North Anna Unit 1**
Reactor Coolant System Heatup Limitations

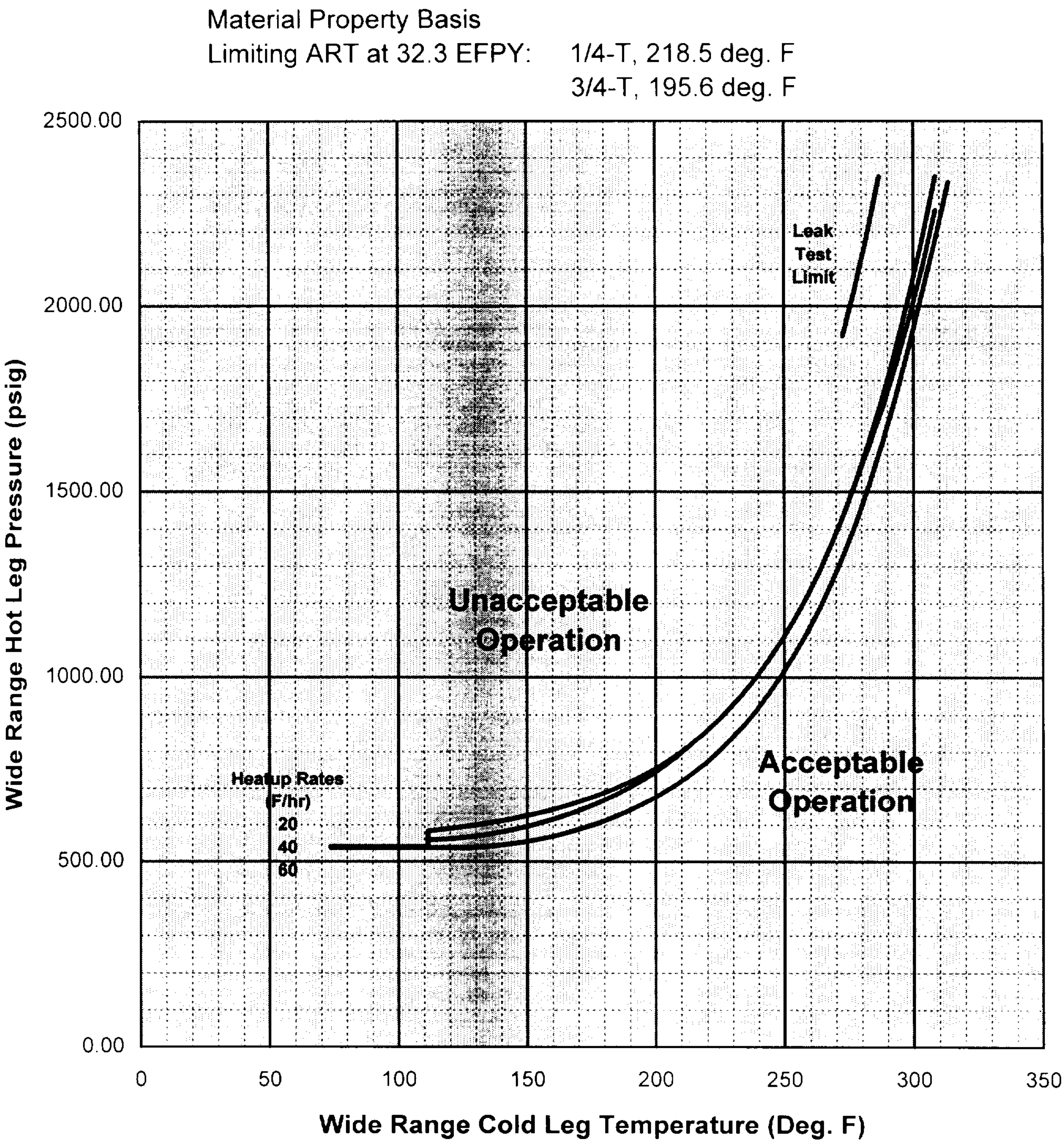
Material Property Basis	
Limiting Material: Circumferential Weld Seam	
Limiting ART at 30.7 EFPY:	1/4-T, 162.9 F
	3/4-T, 139.9



North Anna Unit 1 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr) Applicable for the First 30.7 EFPY (Without Margins for Instrumentation Errors)

Figure 3.4-2

North Anna Unit 1
Reactor Coolant System Heatup Limitations

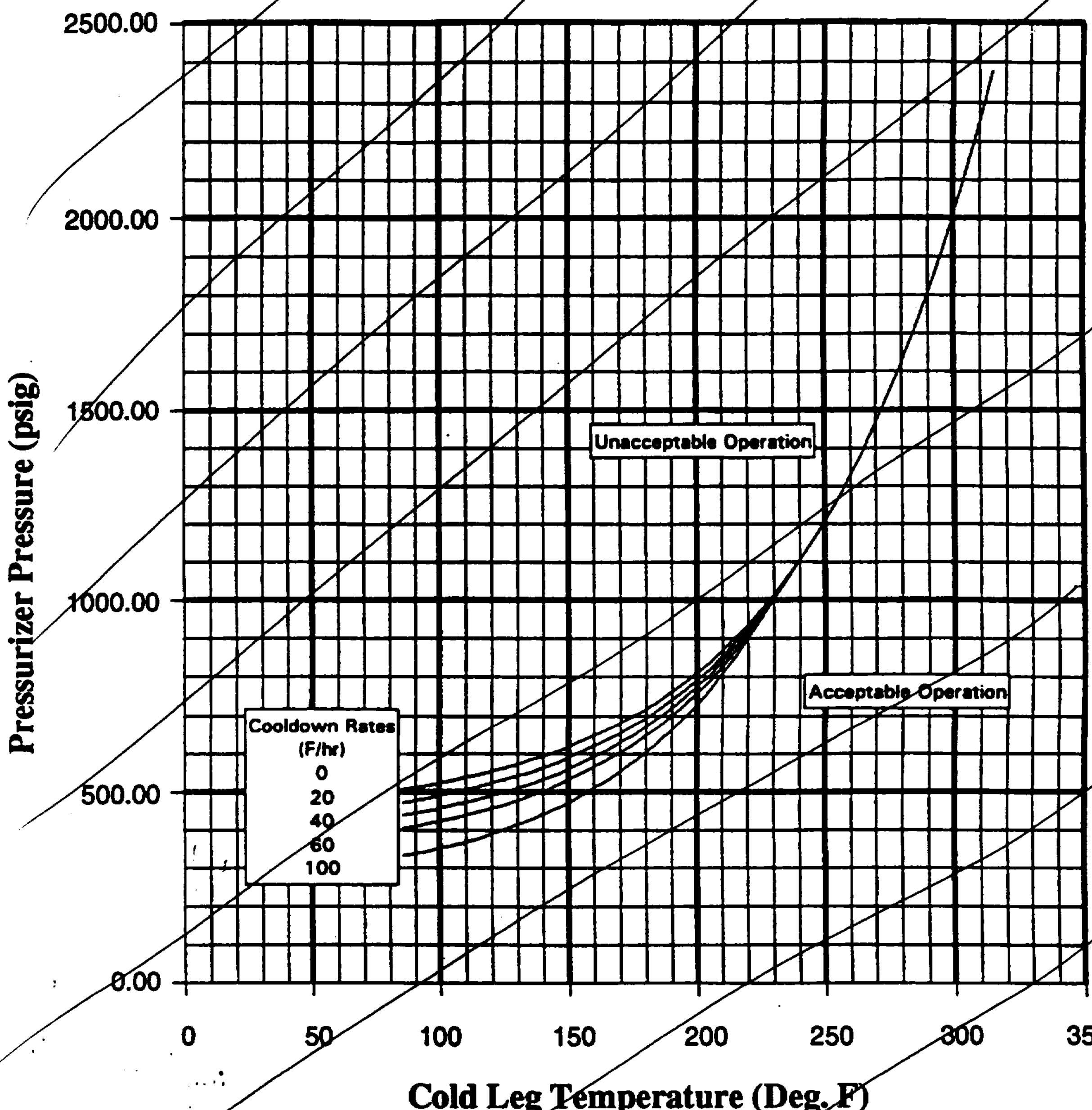


North Anna Unit 1 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr)
Applicable for the first 32.3 EFPY (Including Margins for Instrumentation Errors)

REPLACE WITH ATTACHED FIG 3.4-3

Figure 3.4-3 — North Anna Unit 1
Reactor Coolant System Cooldown Limitations

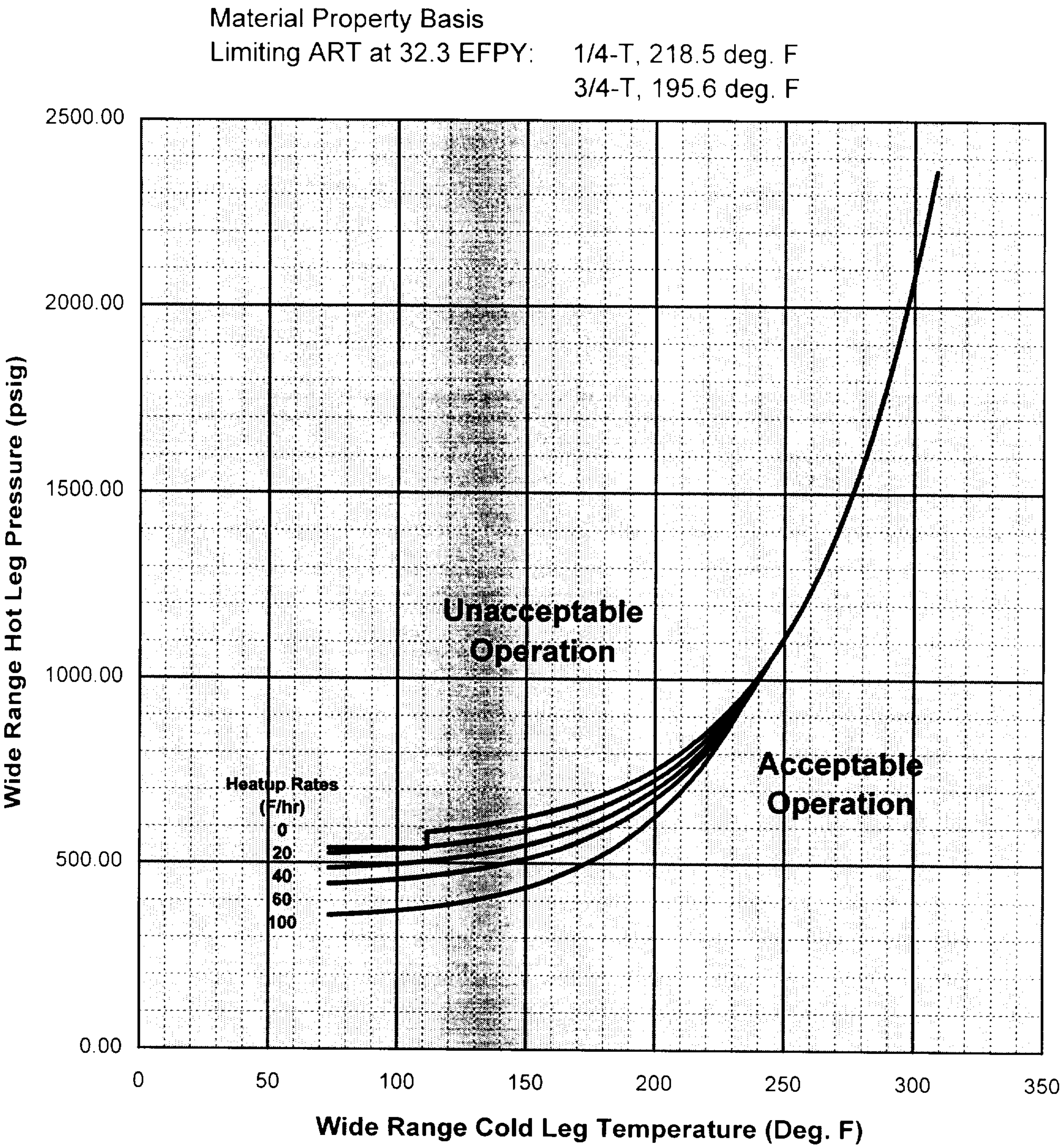
Material Property Basis
Limiting Material: Circumferential Weld Seam
Limiting ART at 30.7 EFPY: 1/4-T, 162.9 F
3/4-T, 139.9 F



North Anna Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr) Applicable for the First 30.7 EFPY (Without Margins for Instrumentation Errors)

Figure 3.4-3

North Anna Unit 1
Reactor Coolant System Cooldown Limitations



North Anna Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr)
Applicable for the first 32.3 EFPY (Including Margins for Instrumentation Errors)

The ACTION statement permitting POWER OPERATION to continue for limited time periods with the primary coolant's specific activity > 1.0 ~μCi/gram DOSE EQUIVALENT I-131, but within the allowable limit shown on Figure 3.4-1, accommodates possible iodine spiking phenomenon which may occur following changes in THERMAL POWER.

Reducing T_{avg} to < 500°F prevents the release of activity should a steam generator tube rupture since the saturation pressure of the primary coolant is below the lift pressure of the atmospheric steam relief valves. The surveillance requirements provide adequate assurance that excessive specific activity levels in the primary coolant will be detected in sufficient time to take corrective action. Information obtained on iodine spiking will be used to assess the parameters associated with spiking phenomena. A reduction in frequency of isotopic analyses following power changes may be permissible if justified by the data obtained.

3/4.4.9 PRESSURE / TEMPERATURE LIMITS

Reactor Coolant System

All components in the Reactor Coolant System are designed to withstand the effects of cyclic loads due to system temperature and pressure changes. These cyclic loads are introduced by normal load transients, reactor trips, and startup and shutdown operations. The various categories of load cycles used for design purposes are provided in Section 5.2 of the UFSAR. During startup and shutdown, the rates of temperature and pressure changes are limited so that the maximum specified heatup and cooldown rates are consistent with the design assumptions and satisfy the stress limits for cyclic operation.

During heatup, the thermal gradients in the reactor vessel wall produce thermal stresses which vary from compressive at the inner wall to tensile at the outer wall. These thermal induced compressive stresses tend to alleviate the tensile stresses induced by the internal pressure. Therefore, a pressure-temperature curve based on steady state conditions (i.e., no thermal stresses) represents a lower bound of all similar curves for finite heatup rates when the inner wall of the vessel is treated as the governing location.

The heatup analysis also covers the determination of pressure- temperature limitations for the case in which the outer wall of the vessel becomes the controlling location. The thermal gradients established during heatup produce tensile stresses at the outer wall of the vessel. These stresses are additive to the pressure induced tensile stresses which are already present. The thermal induced stresses at the outer wall of the vessel are tensile and are dependent on both the rate of heatup and the time along the heatup ramp; therefore, a lower bound curve similar to that described for the heatup of the inner wall cannot be defined. Consequently, for the cases in which the outer wall of the vessel becomes the stress controlling location, each heatup rate of interest must be analyzed on an individual basis.

The heatup limit curve, Figure 3.4-2, is a composite curve which was prepared by determining the most conservative case, with either the inside or outside wall controlling, for any heatup rate up to 60°F per hour. The cooldown limit curves of Figure 3.4-3 are composite curves which were prepared based upon the same type analysis with the exception that the controlling location is always the inside wall where the cooldown thermal gradients tend to produce tensile stresses while producing compressive stresses at the outside wall. The heatup and cooldown curves were prepared based upon the most limiting value of the predicted adjusted reference temperature at the end of 30.7 EFPY. The most recent capsule analysis results are documented in Westinghouse Report WCAP-11777, February 1988. The heatup and cooldown curves are documented in Westinghouse Report WCAP-13831, Rev. 1, August 1993.

The reactor vessel materials have been tested to determine their initial RT_{NDT}. Reactor operation and resultant fast neutron (E > 1 Mev) irradiation will cause an increase in the RT_{NDT}. An adjusted reference temperature, based upon the fluence and copper content of the material in question, can be predicted using US NRC Regulatory Guide 1.98, Revision 2. The heatup and cooldown limit curves (Figure 3.4-2 and Figure 3.4-3) include predicted adjustments for this shift in RT_{NDT} at the end of 30.7 EFPY. The reactor vessel beltline region material properties are listed on Figures 3.4-2 and 3.4-3.

The actual shift in the RT_{NDT} of the vessel material ~~will be~~ established periodically by removal and evaluation of the reactor vessel material specimens installed on the inside wall of the thermal shield. The surveillance capsule withdrawal schedule was prepared in accordance with the requirements of ASTM E-185 and is presented in the UFSAR. Regulatory Guide 1.99, Revision 2, provides guidance for calculation of the shift in RT_{NDT} using measured data. Dosimetry from the surveillance capsule is used to determine the neutron fluence to which the material specimens were exposed, and to support calculational estimates of the neutron fluence to the reactor vessel.

The pressure-temperature limit lines shown on Figure 3.4-2 for inservice leak and hydrostatic testing have been provided to assure compliance with the minimum temperature requirements of Appendix G to 10 CFR 50. The minimum temperature for criticality specified in T.S. 3.1.1.5 assures compliance with the criticality limits of 10 CFR 50 Appendix G.

The number of reactor vessel irradiation surveillance specimens and the frequencies for removing and testing these specimens are provided in the UFSAR to assure compliance with the requirements of Appendix H to 10 CFR Part 50.

Pressurizer

The limitations imposed on pressurizer heatup and cooldown and spray water temperature differential are provided to assure that the pressurizer is operated within the design criteria assumed for the fatigue analysis performed in accordance with the ASME Code requirements.

INSERT 1A

The heatup and cooldown curves of Figures 3.4-2 and 3.4-3 are based upon a 1/4-T RT_{NDT} value of 218.5°F and a 3/4-T RT_{NDT} value of 195.6°F. These RT_{NDT} values conservatively bound the predicted reactor vessel beltline RT_{NDT} values for North Anna Unit 1 operation through 32.3 EFPY. The heatup and cooldown limits include margins to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

INSERT 1B

An adjusted reference temperature, based upon the fluence and copper content of the material in question, can be predicted using US NRC Regulatory Guide 1.99, Revision 2. The heatup and cooldown limit curves (Figure 3.4-2 and Figure 3.4-3) include adjustments for this predicted shift in RT_{NDT} at the end of 32.3 EFPY.

INSERT 1C

Dosimetry from the surveillance capsule is used to provide benchmarks for the calculation of the neutron fluence to which the material specimens and the reactor vessel were exposed.

Low-Temperature Overpressure Protection

The OPERABILITY of two PORVs or an RCS vent opening of greater than 2.07 square inches ensures that the RCS will be protected from pressure transients which could exceed the limits of Appendix G to 10 CFR Part 50 when one or more of the RCS cold legs are less than or equal to 235°F. Either PORV has adequate relieving capability to protect the RCS from overpressurization when the transient is limited to either (1) the start of an idle RCP with the secondary water temperature of the steam generator less than or equal to 50°F above the RCS cold leg temperatures or (2) the start of a charging pump and its injection into a water-solid RCS.

Automatic or passive low temperature overpressure protection (LTOP) is required whenever any RCS cold leg temperature is less than 235°F. This temperature is the water temperature corresponding to a metal temperature of at least the limiting RT_{NDT} + 50°F + instrument uncertainty. Above 235°F administrative control is adequate protection to ensure the limits of the heatup curve (Figure 3.4-2) and the cooldown curve (Figure 3.4-3) are not violated. The concept of requiring automatic LTOP at the lower end, and administrative control at the upper end, of the Appendix G curves is further discussed in NRC Generic Letter 88-11.

Surveillance limits are established for the pressure in the backup nitrogen accumulators to ensure there is adequate motive power for the PORVs to cope with an inadvertent start of a high head safety injection pump in a water solid condition, allowing adequate time for the operators to respond to terminate the event.

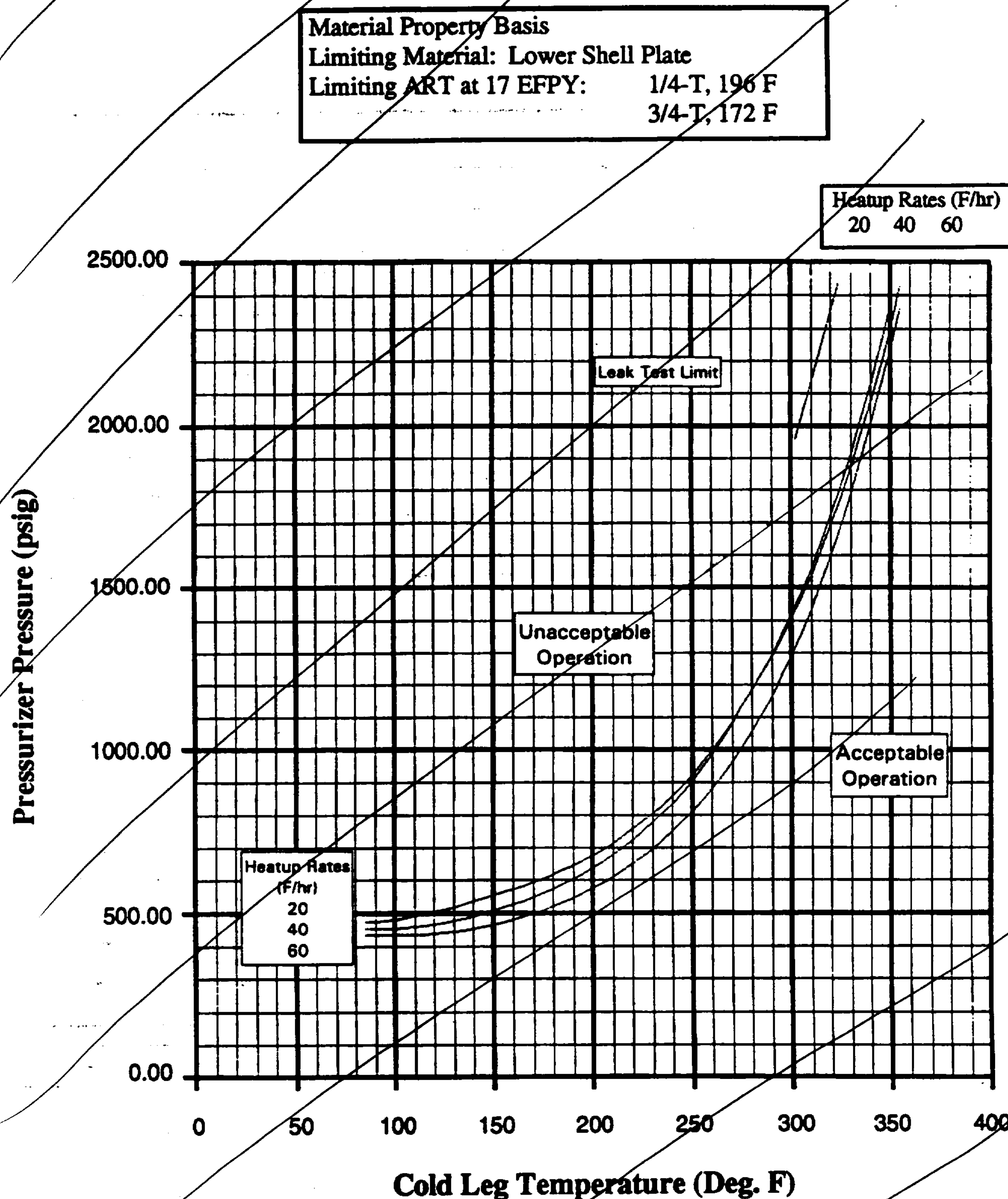
INSERT 2

The low temperature PORV lift setpoints were established to ensure that pressure at the reactor vessel beltline during these design basis events will not exceed 100% of the 10 CFR 50 Appendix G isothermal limit curve when the LTOP system is enabled. The LTOPS design basis pressure-temperature limit curve includes margin to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

Mark-up of Unit 2 Technical Specifications Changes

REPLACE WITH ATTACHED FIG 3.4-2

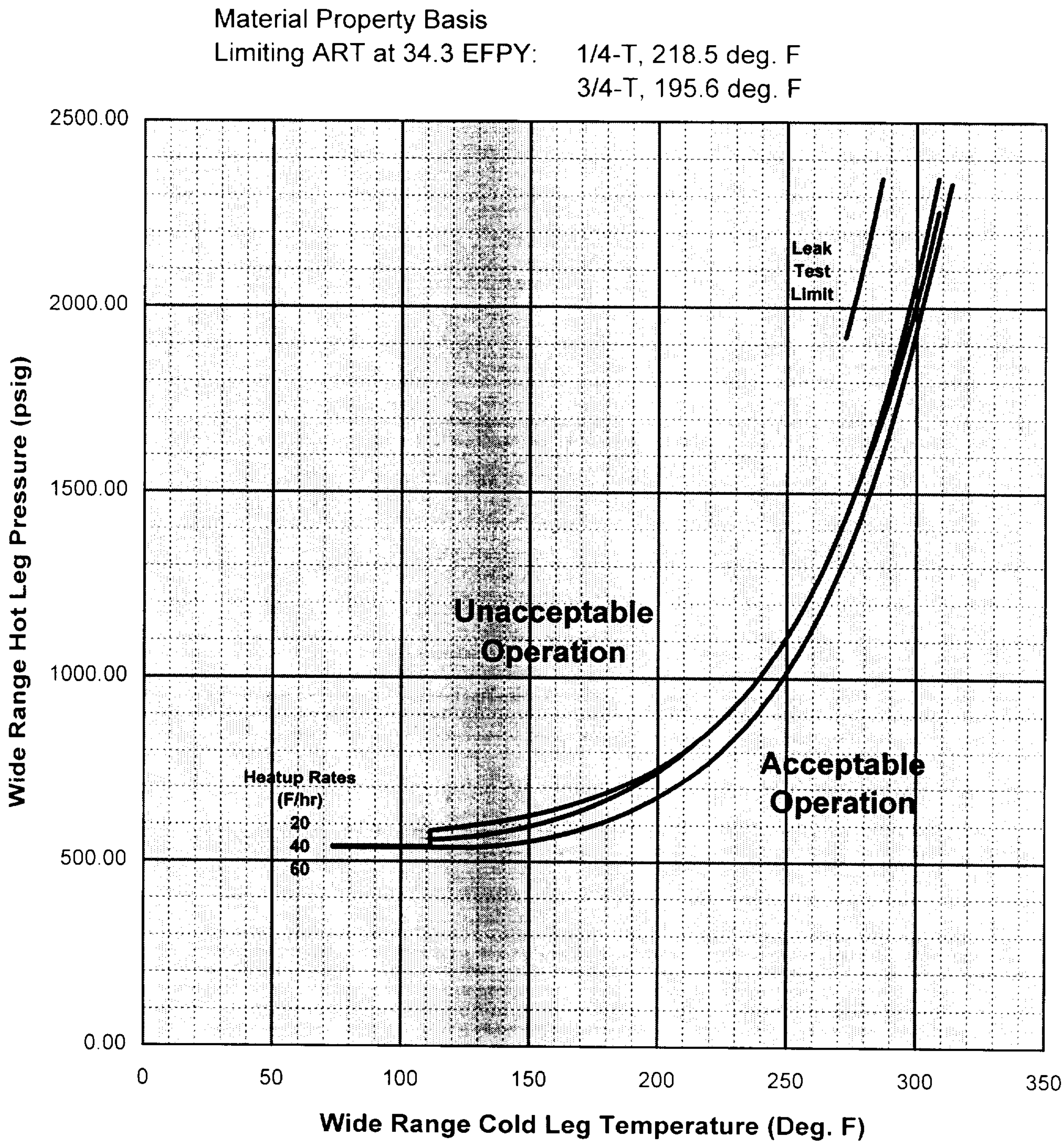
Figure 3.4-2 — North Anna Unit 2
Reactor Coolant System Heatup Limitations



North Anna Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr) Applicable for the First 17 EFPY (Without Margins for Instrumentation Errors)

Figure 3.4-2

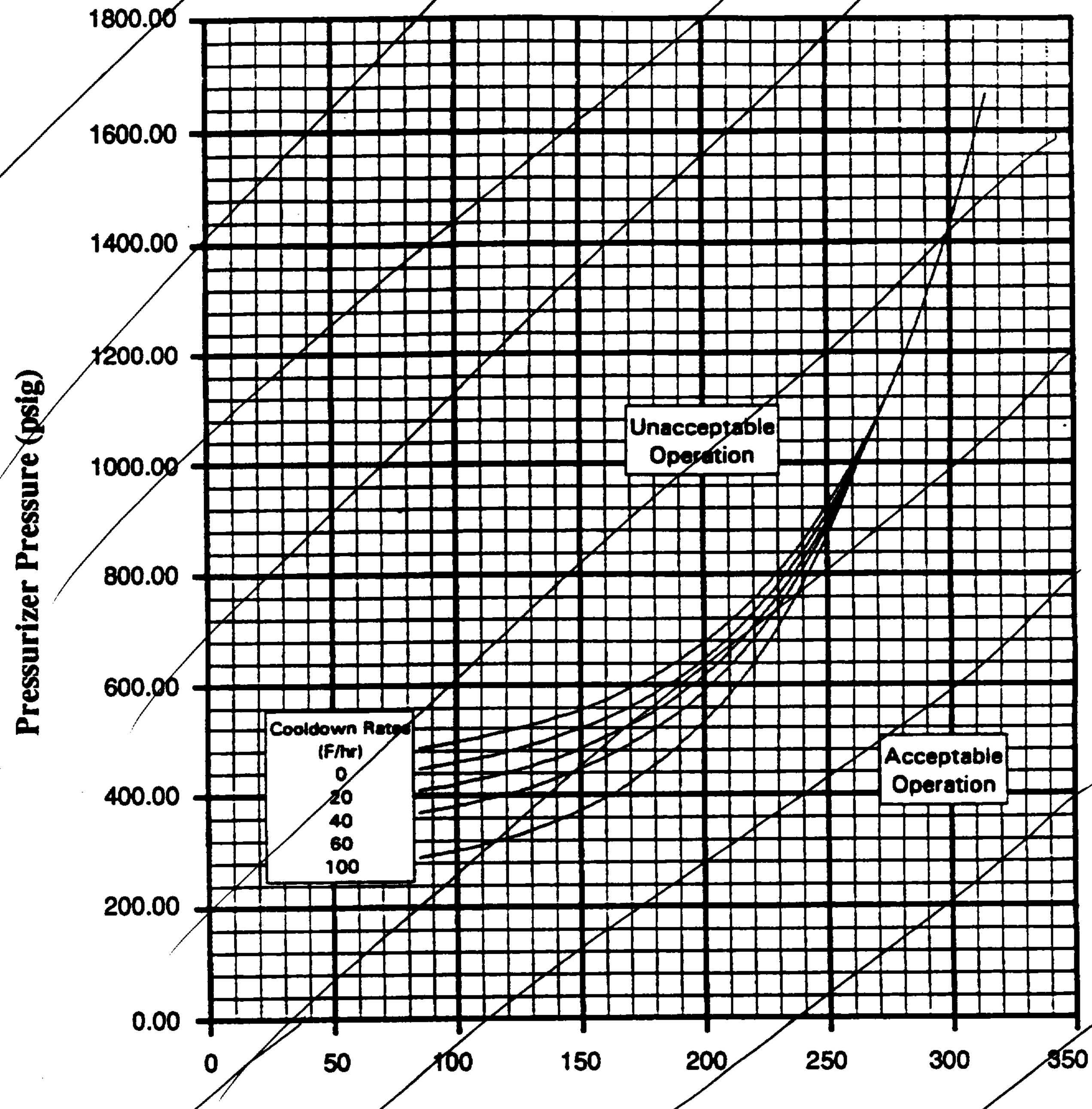
North Anna Unit 2
Reactor Coolant System Heatup Limitations



North Anna Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

Figure 3.4-3 — North Anna Unit 2
Reactor Coolant System Cooldown Limitations

Material Property Basis		
Limiting Material: Lower Shell Plate		
Limiting ART at 17 EFPY:	1/4-T, 196 F	
	3/4-T, 172 F	

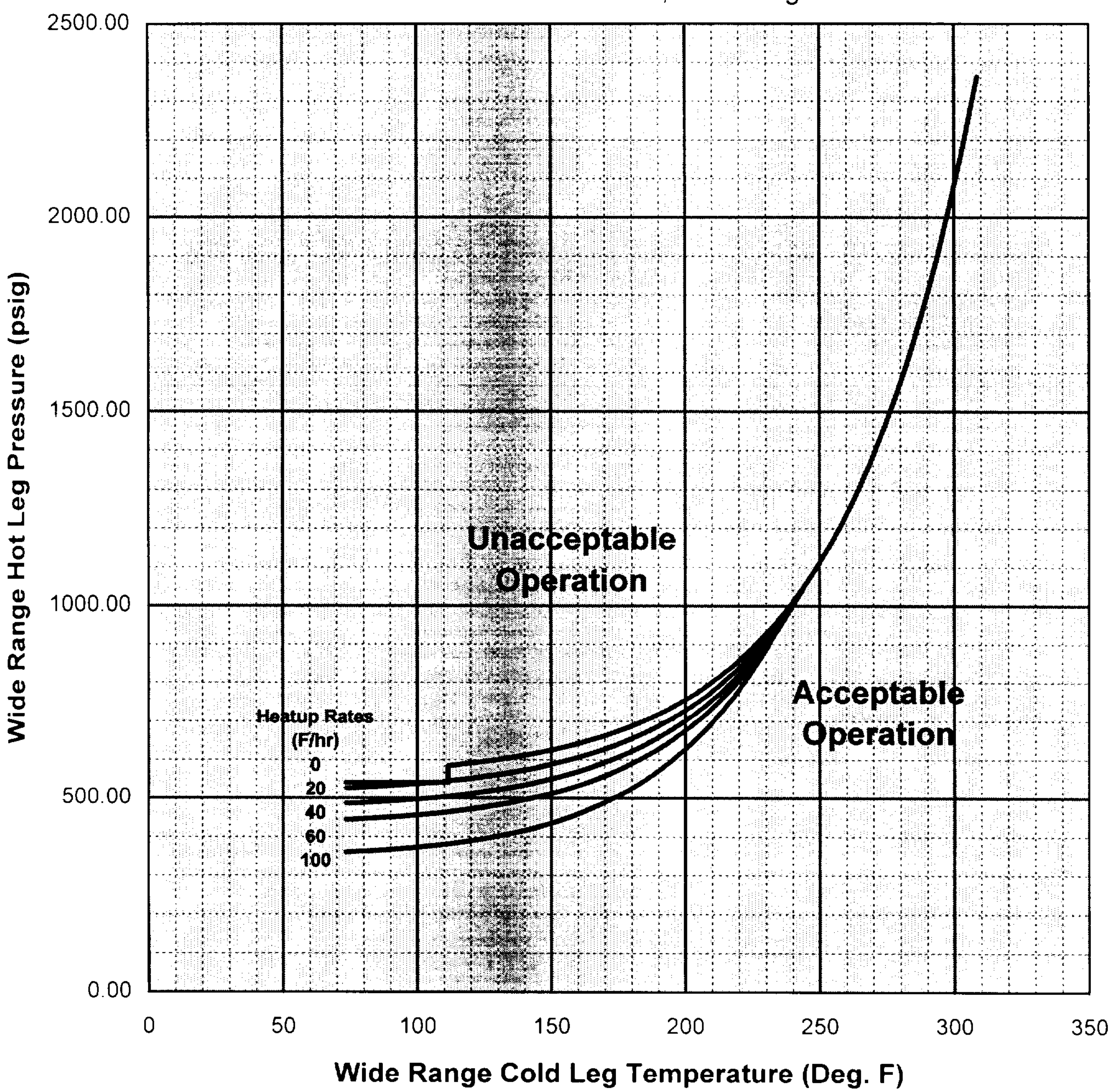


North Anna Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr) Applicable for the First 17 EFPY (Without Margins for Instrumentation Errors)

Figure 3.4-3

North Anna Unit 2
Reactor Coolant System Cooldown Limitations

Material Property Basis
Limiting ART at 34.3 EFPY: 1/4-T, 218.5 deg. F
3/4-T, 195.6 deg. F



North Anna Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

The ACTION statement permitting POWER OPERATION to continue for limited time periods with the primary coolant's specific activity greater than 1.0 ~μCi/gram DOSE EQUIVALENT I-131, but within the allowable limit shown on Figure 3.4-1, accommodates possible iodine spiking phenomenon which may occur following changes in THERMAL POWER.

Reducing T_{avg} to less than 500°F prevents the release of activity should a steam generator tube rupture since the saturation pressure of the primary coolant is below the lift pressure of the atmospheric steam relief valves. The surveillance requirements provide adequate assurance that excessive specific activity levels in the primary coolant will be detected in sufficient time to take corrective action. Information obtained on iodine spiking will be used to assess the parameters associated with spiking phenomena. A reduction in frequency of isotopic analyses following power changes may be permissible if justified by the data obtained.

3/4.4.9 PRESSURE / TEMPERATURE LIMITS

Reactor Coolant System

All components in the Reactor Coolant System are designed to withstand the effects of cyclic loads due to system temperature and pressure changes. These cyclic loads are introduced by normal load transients, reactor trips, and startup and shutdown operations. The various categories of load cycles used for design purposes are provided in Section 5.2 of the UFSAR. During startup and shutdown, the rates of temperature and pressure changes are limited so that the maximum specified heatup and cooldown rates are consistent with the design assumptions and satisfy the stress limits for cyclic operation.

During heatup, the thermal gradients in the reactor vessel wall produce thermal stresses which vary from compressive at the inner wall to tensile at the outer wall. These thermal induced compressive stresses tend to alleviate the tensile stresses induced by the internal pressure. Therefore, a pressure-temperature curve based on steady state conditions (i.e., no thermal stresses) represents a lower bound of all similar curves for finite heatup rates when the inner wall of the vessel is treated as the governing location.

The heatup analysis also covers the determination of pressure-temperature limitations for the case in which the outer wall of the vessel becomes the controlling location. The thermal gradients established during heatup produce tensile stresses at the outer wall of the vessel. These stresses are additive to the pressure induced tensile stresses which are already present. The thermal induced stresses at the outer wall of the vessel are tensile and are dependent on both the rate of heatup and the time along the heatup ramp; therefore, a lower bound curve similar to that described for the heatup of the inner wall cannot be defined. Consequently, for the cases in which the outer wall of the vessel becomes the stress controlling location, each heatup rate of interest must be analyzed on an individual basis.

REACTOR COOLANT SYSTEM

BASES

The heatup limit curve, Figure 3.4-2, is a composite curve which was prepared by determining the most conservative case, with either the inside or outside wall controlling, for any heatup rate up to 60°F per hour. The cooldown limit curves of Figure 3.4-3 are composite curves which were prepared based upon the same type analysis with the exception that the controlling location is always the inside wall where the cooldown thermal gradients tend to produce tensile stresses while producing compressive stresses at the outside wall. The heatup and cooldown curves were prepared based upon the most limiting value of the predicted adjusted reference temperature at the end of 17 EFPY. The most recent capsule analysis results are documented in Westinghouse Reports WCAP-12497, January 1990. The heatup and cooldown curves are documented in Westinghouse Report WCAP-12503, March, 1990. INSERT 3A

The reactor vessel materials have been tested to determine their initial RT_{NDT}. Reactor operation and resultant fast neutron (E > 1 Mev) irradiation will cause an increase in the RT_{NDT}. An adjusted reference temperature, based upon the fluence and copper content of the material in question, can be predicted using US NRC Regulatory Guide 1.98, Revision 2. The heatup and cooldown limit curves (Figure 3.4-2 and Figure 3.4-3) include predicted adjustments for this shift in RT_{NDT} at the end of 17 EFPY. The reactor vessel beltline region material properties are listed on Figures 3.4-2 and 3.4-3. INSERT 3B

The actual shift in the RT_{NDT} of the vessel material ~~will be~~ is established periodically by removal and evaluation of the reactor vessel material specimens installed on the inside wall of the thermal shield. The surveillance capsule withdrawal schedule was prepared in accordance with the requirements of ASTM E-185 and is presented in the UFSAR. Regulatory Guide 1.99, Revision 2, provides guidance for calculation of the shift in RT_{NDT} using measured data. Dosimetry from the surveillance capsule is used to determine the neutron fluence to which the material specimens were exposed, and to support calculational estimates of the neutron fluence to the reactor vessel. INSERT 3C

The pressure-temperature limit lines shown on Figure 3.4-2 for inservice leak and hydrostatic testing have been provided to assure compliance with the minimum temperature requirements of Appendix G to 10 CFR 50. The minimum temperature for criticality specified in T.S. 3.1.1.5 assures compliance with the criticality limits of 10 CFR 50 Appendix G.

The number of reactor vessel irradiation surveillance specimens and the frequencies for removing and testing these specimens are provided in the UFSAR to assure compliance with the requirements of Appendix H to 10 CFR Part 50.

Pressurizer

The limitations imposed on pressurizer heatup and cooldown and spray water temperature differential are provided to assure that the pressurizer is operated within the design criteria assumed for the fatigue analysis performed in accordance with the ASME Code requirements.

INSERT 3A

The heatup and cooldown curves of Figures 3.4-2 and 3.4-3 are based upon a 1/4-T RT_{NDT} value of 218.5°F and a 3/4-T RT_{NDT} value of 195.6°F. These RT_{NDT} values conservatively bound the predicted reactor vessel beltline RT_{NDT} values for North Anna Unit 2 operation through 34.3 EFPY. The heatup and cooldown limits include margins to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

INSERT 3B

An adjusted reference temperature, based upon the fluence and copper content of the material in question, can be predicted using US NRC Regulatory Guide 1.99, Revision 2. The heatup and cooldown limit curves (Figure 3.4-2 and Figure 3.4-3) include adjustments for this predicted shift in RT_{NDT} at the end of 34.3 EFPY.

INSERT 3C

Dosimetry from the surveillance capsule is used to provide benchmarks for the calculation of the neutron fluence to which the material specimens and the reactor vessel were exposed.

Low-Temperature Overpressure Protection

The OPERABILITY of two PORVs or an RCS vent opening of greater than 2.07 square inches ensures that the RCS will be protected from pressure transients which could exceed the limits of Appendix G to 10 CFR Part 50 when one or more of the RCS cold legs are less than or equal to 270°F. Either PORV has adequate relieving capability to protect the RCS from overpressurization when the transient is limited to either (1) the start of an idle RCP with the secondary water temperature of the steam generator less than or equal to 50°F above the RCS cold leg temperatures or (2) the start of a charging pump and its injection into a water-solid RCS. ← INSERT (4)

Automatic or passive low temperature overpressure protection (LTOP) is required whenever any RCS cold leg temperature is less than 270°F. This temperature ~~is~~ CONSERVATIVELY BOUNDS the water temperature corresponding to a metal temperature of ~~at least~~ the limiting RT_{NDT} + (50°F) 31.9°F + instrument uncertainty. Above 270°F administrative control is adequate protection to ensure the limits of the heatup curve (Figure 3.4-2) and the cooldown curve (Figure 3.4-3) are not violated. The concept of requiring automatic LTOP at the lower end, and administrative control at the upper end, of the Appendix G curves is further discussed in NRC Generic Letter 88-11.

Surveillance limits are established for the pressure in the backup nitrogen accumulators to ensure there is adequate motive power for the PORVs to cope with an inadvertent start of a high head safety injection pump in a water solid condition, allowing adequate time for the operators to respond to terminate the event.

3/4.4.10 STRUCTURAL INTEGRITY

3/4.4.10.1 ASME CODE CLASS 1, 2 and 3 COMPONENTS

The inspection programs for ASME Code Class 1, 2 and 3 Reactor Coolant System components ensure that the structural integrity of these components will be maintained at an acceptable level throughout the life of the plant. To the extent applicable, the inspection program for components is in compliance with Section XI of the ASME Boiler and Pressure Vessel Code.

INSERT 4

The low temperature PORV lift setpoints were established to ensure that pressure at the reactor vessel beltline during these design basis events will not exceed 100% of the 10 CFR 50 Appendix G isothermal limit curve when the LTOP system is enabled. The LTOPS design basis pressure-temperature limit curve includes margin to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

Attachment 3

Proposed Unit 1 and Unit 2 Technical Specifications Changes

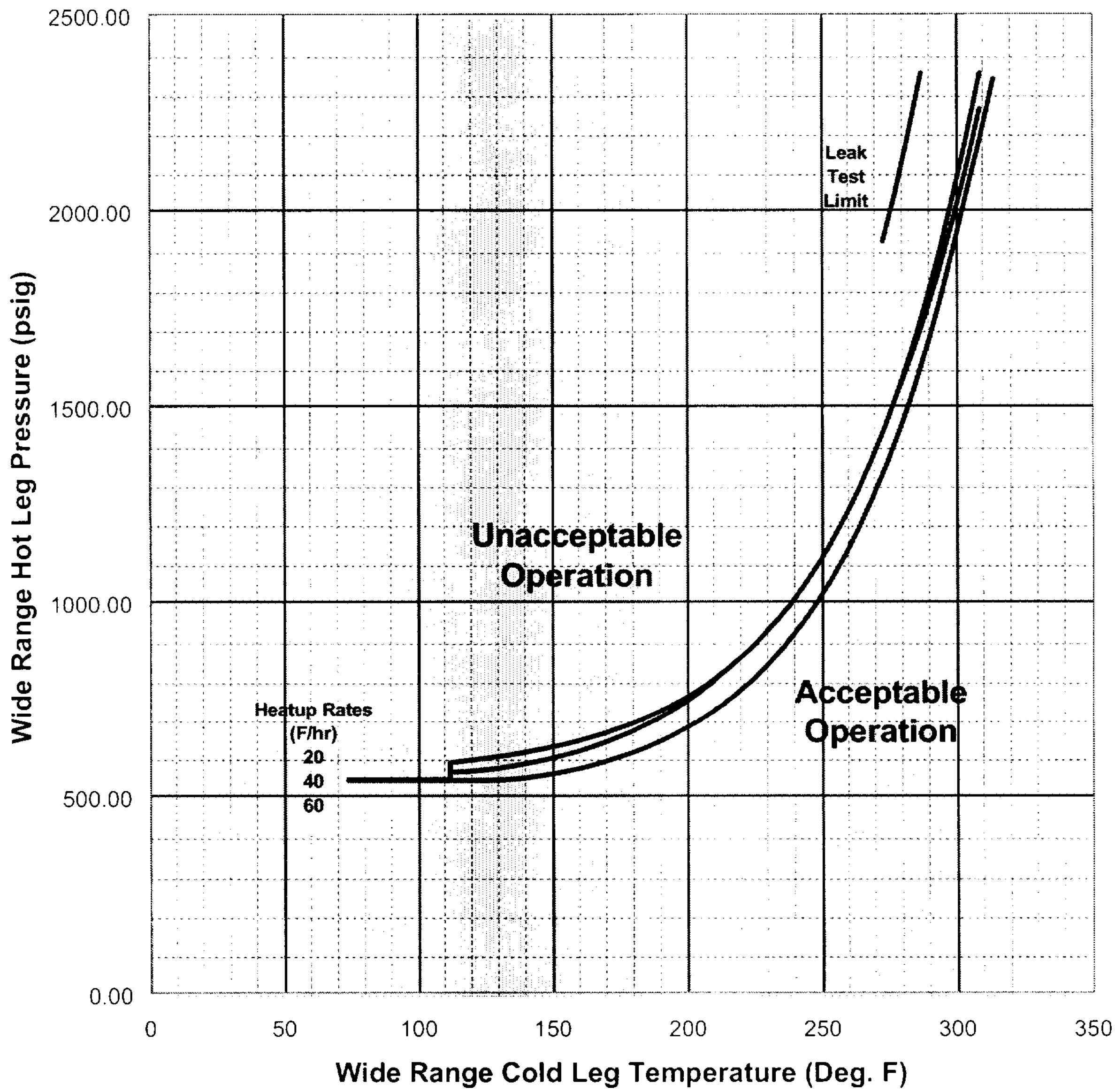
North Anna Power Station
Units 1 and 2
Virginia Electric and Power Company
(Dominion)

Proposed Unit 1 Technical Specifications Changes

Figure 3.4-2

North Anna Unit 2
Reactor Coolant System Heatup Limitations

Material Property Basis
Limiting ART at 34.3 EFPY: 1/4-T, 218.5 deg. F
3/4-T, 195.6 deg. F

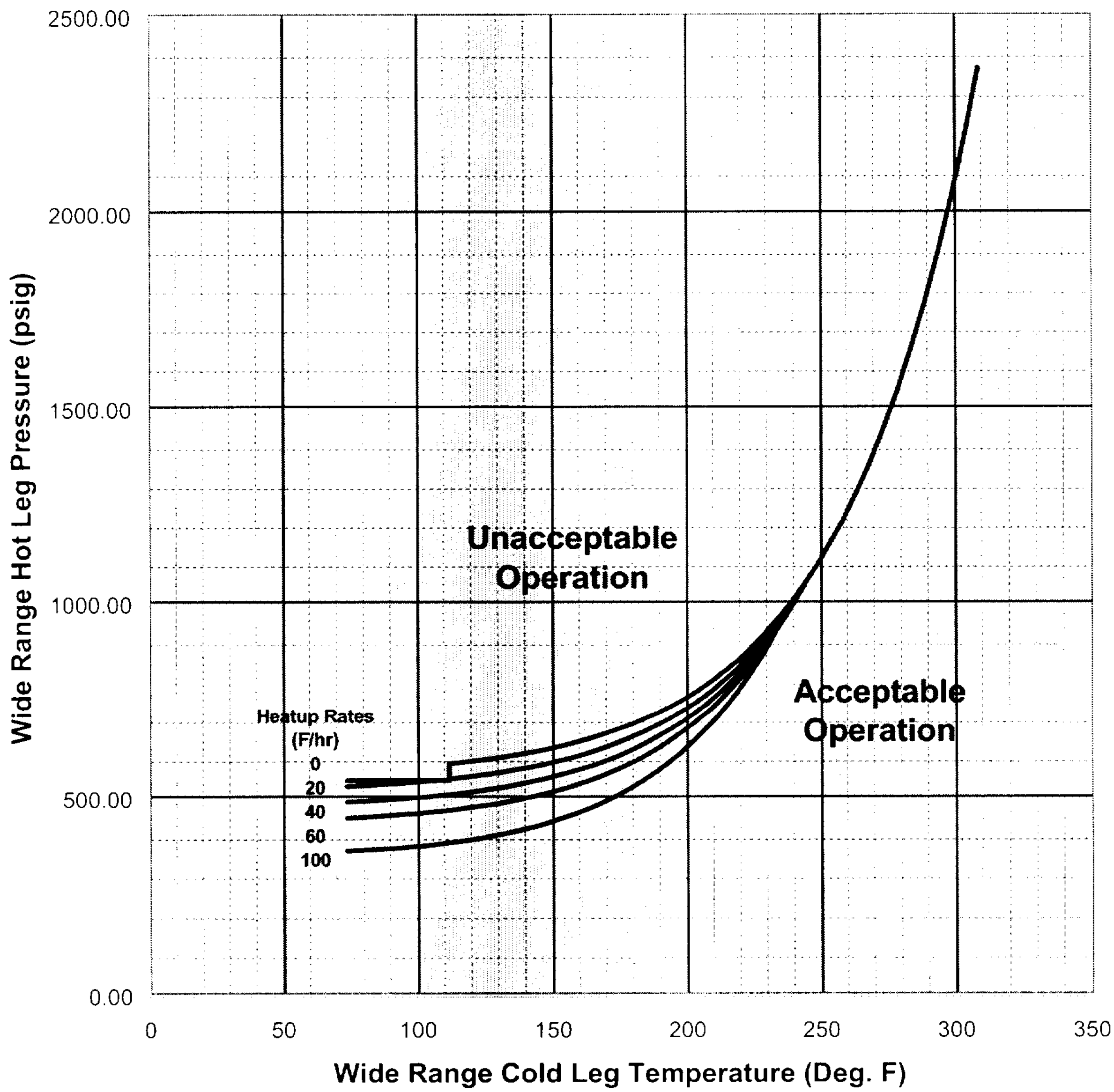


North Anna Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

Figure 3.4-3

North Anna Unit 2
Reactor Coolant System Cooldown Limitations

Material Property Basis
Limiting ART at 34.3 EFPY: 1/4-T, 218.5 deg. F
3/4-T, 195.6 deg. F



North Anna Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

The heatup limit curve, Figure 3.4-2, is a composite curve which was prepared by determining the most conservative case, with either the inside or outside wall controlling, for any heatup rate up to 60°F per hour. The cooldown limit curves of Figure 3.4-3 are composite curves which were prepared based upon the same type analysis with the exception that the controlling location is always the inside wall where the cooldown thermal gradients tend to produce tensile stresses while producing compressive stresses at the outside wall. The heatup and cooldown curves of Figures 3.4-2 and 3.4-3 are based upon a 1/4-T RT_{NDT} value of 218.5°F and a 3/4-T RT_{NDT} value of 195.6°F. These RT_{NDT} values conservatively bound the predicted reactor vessel beltline RT_{NDT} values for North Anna Unit 1 operation through 32.3 EFPY. The heatup and cooldown limits include margins to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

The reactor vessel materials have been tested to determine their initial RT_{NDT}. Reactor operation and resultant fast neutron (E > 1 Mev) irradiation will cause an increase in the RT_{NDT}. An adjusted reference temperature, based upon the fluence and copper content of the material in question, can be predicted using US NRC Regulatory Guide 1.99, Revision 2. The heatup and cooldown limit curves (Figure 3.4-2 and Figure 3.4-3) include adjustments for this predicted shift in RT_{NDT} at the end of 32.3 EFPY.

The actual shift in the RT_{NDT} of the vessel material is established periodically by removal and evaluation of the reactor vessel material specimens installed on the inside wall of the thermal shield. The surveillance capsule withdrawal schedule was prepared in accordance with the requirements of ASTM E-185 and is presented in the UFSAR. Regulatory Guide 1.99, Revision 2, provides guidance for calculation of the shift in RT_{NDT} using measured data. Dosimetry from the surveillance capsule is used to provide benchmarks for the calculation of the neutron fluence to which the material specimens and the reactor vessel were exposed.

The pressure-temperature limit lines shown on Figure 3.4-2 for inservice leak and hydrostatic testing have been provided to assure compliance with the minimum temperature requirements of Appendix G to 10 CFR 50. The minimum temperature for criticality specified in T.S. 3.1.1.5 assures compliance with the criticality limits of 10 CFR 50 Appendix G.

The number of reactor vessel irradiation surveillance specimens and the frequencies for removing and testing these specimens are provided in the UFSAR to assure compliance with the requirements of Appendix H to 10 CFR Part 50.

Pressurizer

The limitations imposed on pressurizer heatup and cooldown and spray water temperature differential are provided to assure that the pressurizer is operated within the design criteria assumed for the fatigue analysis performed in accordance with the ASME Code requirements.

Low-Temperature Overpressure Protection

The OPERABILITY of two PORVs or an RCS vent opening of greater than 2.07 square inches ensures that the RCS will be protected from pressure transients which could exceed the limits of Appendix G to 10 CFR Part 50 when one or more of the RCS cold legs are less than or equal to 235°F. Either PORV has adequate relieving capability to protect the RCS from overpressurization when the transient is limited to either (1) the start of an idle RCP with the secondary water temperature of the steam generator less than or equal to 50°F above the RCS cold leg temperatures or (2) the start of a charging pump and its injection into a water-solid RCS. The low temperature PORV lift setpoints were established to ensure that pressure at the reactor vessel beltline during these design basis events will not exceed 100% of the 10 CFR 50 Appendix G isothermal limit curve when the LTOP system is enabled. The LTOPS design basis pressure-temperature limit curve includes margin to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

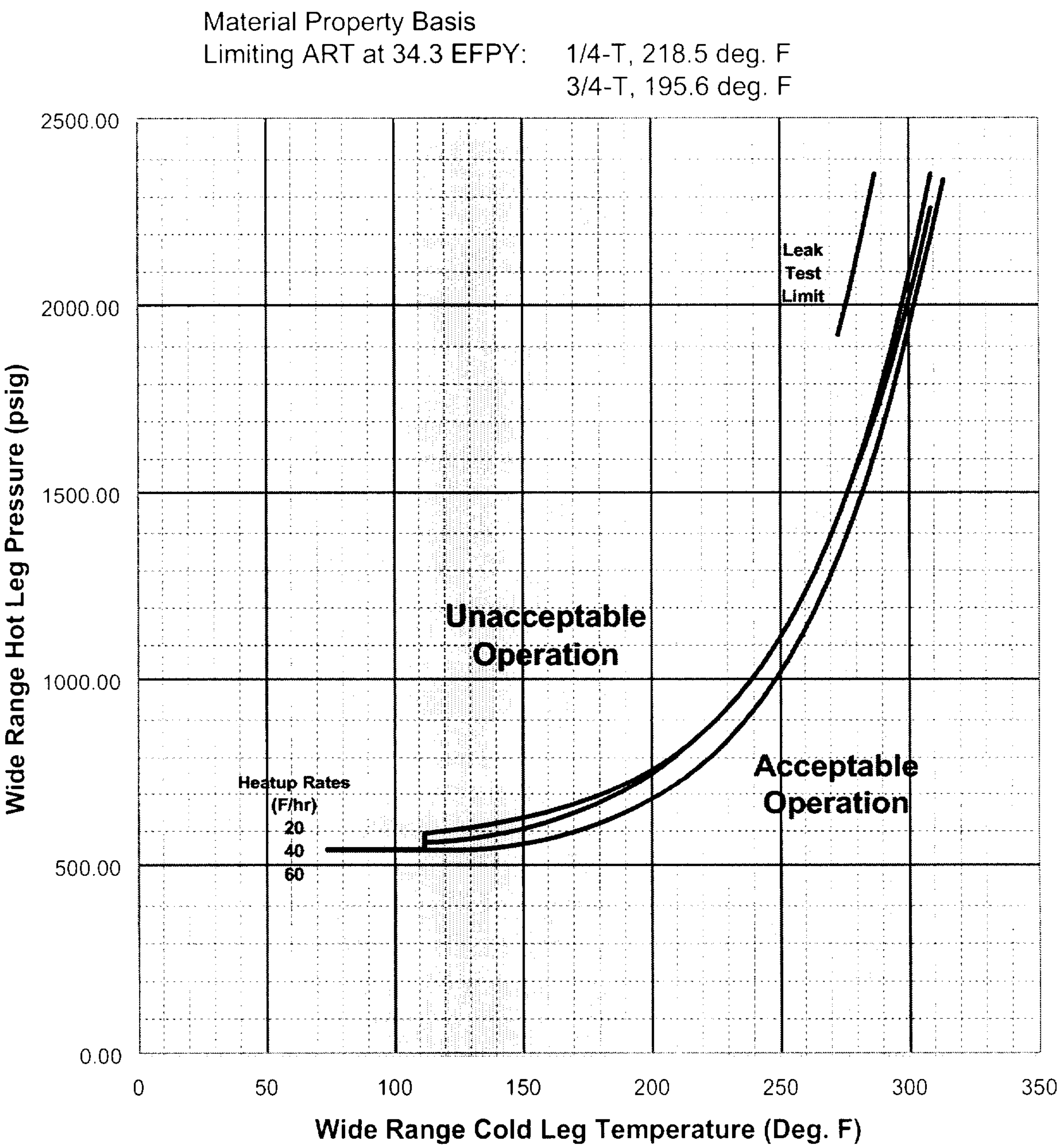
Automatic or passive low temperature overpressure protection (LTOP) is required whenever any RCS cold leg temperature is less than 235°F. This temperature conservatively bounds the water temperature corresponding to a metal temperature of the limiting RT_{NDT} + 31.9°F + instrument uncertainty. Above 235°F administrative control is adequate protection to ensure the limits of the heatup curve (Figure 3.4-2) and the cooldown curve (Figure 3.4-3) are not violated. The concept of requiring automatic LTOP at the lower end, and administrative control at the upper end, of the Appendix G curves is further discussed in NRC Generic Letter 88-11.

Surveillance limits are established for the pressure in the backup nitrogen accumulators to ensure there is adequate motive power for the PORVs to cope with an inadvertent start of a high head safety injection pump in a water solid condition, allowing adequate time for the operators to respond to terminate the event.

Proposed Unit 2 Technical Specifications Changes

Figure 3.4-2

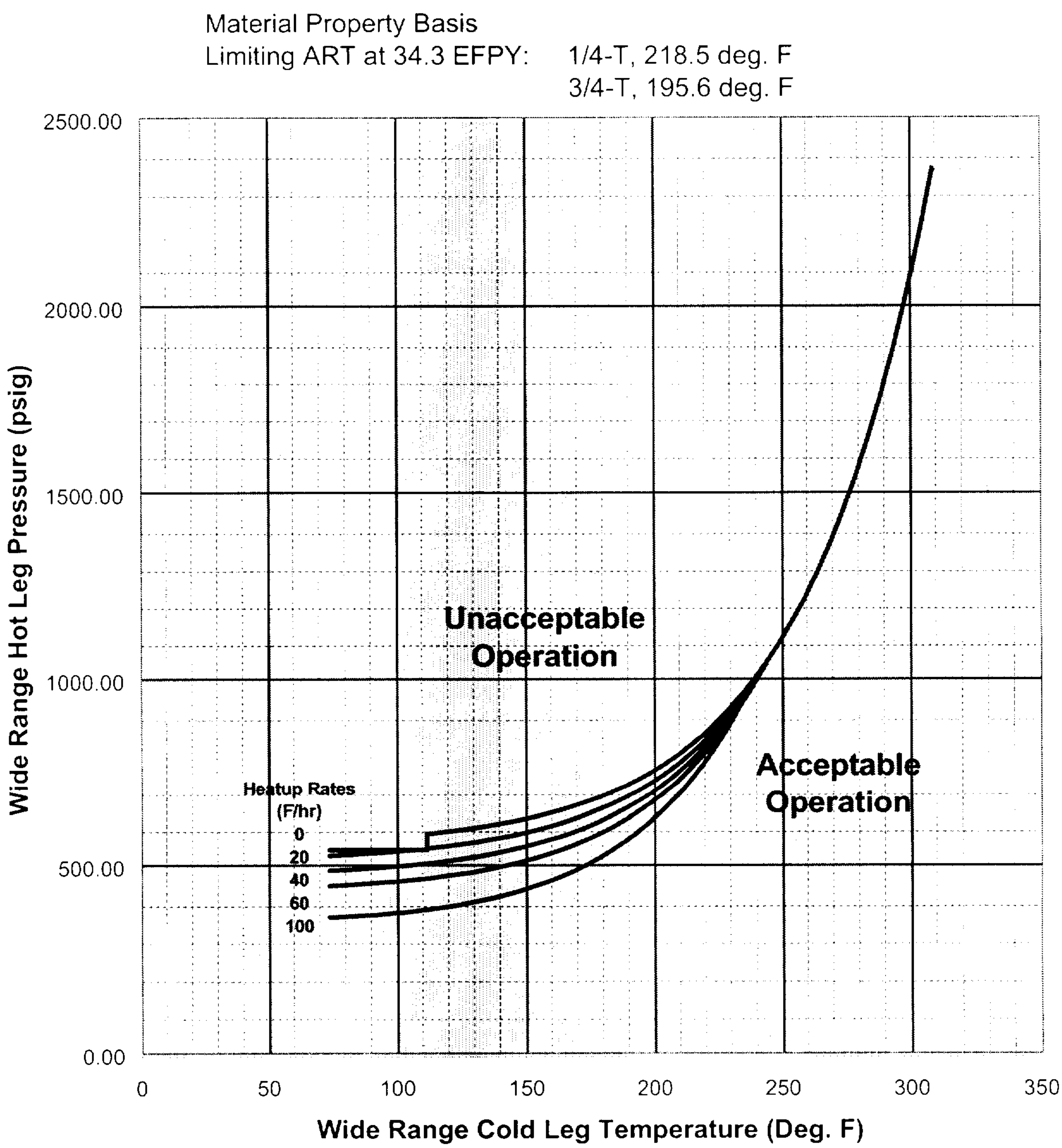
North Anna Unit 2
Reactor Coolant System Heatup Limitations



North Anna Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rates up to 60 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

Figure 3.4-3

North Anna Unit 2
Reactor Coolant System Cooldown Limitations



North Anna Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100 F/hr)
Applicable for the first 34.3 EFPY (Including Margins for Instrumentation Errors)

The heatup limit curve, Figure 3.4-2, is a composite curve which was prepared by determining the most conservative case, with either the inside or outside wall controlling, for any heatup rate up to 60°F per hour. The cooldown limit curves of Figure 3.4-3 are composite curves which were prepared based upon the same type analysis with the exception that the controlling location is always the inside wall where the cooldown thermal gradients tend to produce tensile stresses while producing compressive stresses at the outside wall. The heatup and cooldown curves of Figures 3.4-2 and 3.4-3 are based upon a 1/4-T RT_{NDT} value of 218.5°F and a 3/4-T RT_{NDT} value of 195.6°F. These RT_{NDT} values conservatively bound the predicted reactor vessel beltline RT_{NDT} values for North Anna Unit 2 operation through 34.3 EFPY. The heatup and cooldown limits include margins to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

The reactor vessel materials have been tested to determine their initial RT_{NDT}. Reactor operation and resultant fast neutron (E > 1 Mev) irradiation will cause an increase in the RT_{NDT}. An adjusted reference temperature, based upon the fluence and copper content of the material in question, can be predicted using US NRC Regulatory Guide 1.99, Revision 2. The heatup and cooldown limit curves (Figure 3.4-2 and Figure 3.4-3) include adjustments for this predicted shift in RT_{NDT} at the end of 34.3 EFPY.

The actual shift in the RT_{NDT} of the vessel material is established periodically by removal and evaluation of the reactor vessel material specimens installed on the inside wall of the thermal shield. The surveillance capsule withdrawal schedule was prepared in accordance with the requirements of ASTM E-185 and is presented in the UFSAR. Regulatory Guide 1.99, Revision 2, provides guidance for calculation of the shift in RT_{NDT} using measured data. Dosimetry from the surveillance capsule is used to provide benchmarks for the calculation of the neutron fluence to which the material specimens and the reactor vessel were exposed.

The pressure-temperature limit lines shown on Figure 3.4-2 for inservice leak and hydrostatic testing have been provided to assure compliance with the minimum temperature requirements of Appendix G to 10 CFR 50. The minimum temperature for criticality specified in T.S. 3.1.1.5 assures compliance with the criticality limits of 10 CFR 50 Appendix G.

The number of reactor vessel irradiation surveillance specimens and the frequencies for removing and testing these specimens are provided in the UFSAR to assure compliance with the requirements of Appendix H to 10 CFR Part 50.

Pressurizer

The limitations imposed on pressurizer heatup and cooldown and spray water temperature differential are provided to assure that the pressurizer is operated within the design criteria assumed for the fatigue analysis performed in accordance with the ASME Code requirements.

Low-Temperature Overpressure Protection

The OPERABILITY of two PORVs or an RCS vent opening of greater than 2.07 square inches ensures that the RCS will be protected from pressure transients which could exceed the limits of Appendix G to 10 CFR Part 50 when one or more of the RCS cold legs are less than or equal to 270°F. Either PORV has adequate relieving capability to protect the RCS from overpressurization when the transient is limited to either (1) the start of an idle RCP with the secondary water temperature of the steam generator less than or equal to 50°F above the RCS cold leg temperatures or (2) the start of a charging pump and its injection into a water-solid RCS. The low temperature PORV lift setpoints were established to ensure that pressure at the reactor vessel beltline during these design basis events will not exceed 100% of the 10 CFR 50 Appendix G isothermal limit curve when the LTOP system is enabled. The LTOPS design basis pressure-temperature limit curve includes margin to accommodate pressure and temperature measurement uncertainty, and the pressure difference between the point of measurement (RCS hot leg) and the point of interest (reactor vessel beltline).

Automatic or passive low temperature overpressure protection (LTOP) is required whenever any RCS cold leg temperature is less than 270°F. This temperature conservatively bounds the water temperature corresponding to a metal temperature of the limiting RT_{NDT} + 31.9°F + instrument uncertainty. Above 270°F administrative control is adequate protection to ensure the limits of the heatup curve (Figure 3.4-2) and the cooldown curve (Figure 3.4-3) are not violated. The concept of requiring automatic LTOP at the lower end, and administrative control at the upper end, of the Appendix G curves is further discussed in NRC Generic Letter 88-11.

Surveillance limits are established for the pressure in the backup nitrogen accumulators to ensure there is adequate motive power for the PORVs to cope with an inadvertent start of a high head safety injection pump in a water solid condition, allowing adequate time for the operators to respond to terminate the event.

3/4.4.10 STRUCTURAL INTEGRITY

3/4.4.10.1 ASME CODE CLASS 1, 2 and 3 COMPONENTS

The inspection programs for ASME Code Class 1, 2 and 3 Reactor Coolant System components ensure that the structural integrity of these components will be maintained at an acceptable level throughout the life of the plant. To the extent applicable, the inspection program for components is in compliance with Section XI of the ASME Boiler and Pressure Vessel Code.

Attachment 4

Significant Hazards Consideration Determination

North Anna Power Station
Units 1 and 2
Virginia Electric and Power Company
(Dominion)

SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

Virginia Electric and Power Company (Dominion) has reviewed the requirements of 10 CFR 50.92 as they relate to the proposed changes for the North Anna Units 1 and 2 and determined that a significant hazards consideration is not involved. The proposed amendments to the North Anna Units 1 and 2 Technical Specifications modify the Reactor Coolant System (RCS) pressure/temperature (P/T) limit curves, and extend the cumulative core burnup applicability limits for the existing Low Temperature Overpressure Protection System (LTOPS) setpoints and LTOPS enable temperature (T_{enable}) values. The proposed P/T limit curves, LTOPS setpoints, and LTOPS T_{enable} values are valid to cumulative core burnups of 32.3 EFPY and 34.3 EFPY for North Anna Units 1 and 2, respectively.

The proposed revised RCS P/T limit curves utilize ASME Section XI Code Case N-640, which supports use of a conservative but less restrictive stress intensity formulation (K_{1c}). The proposed extension of the cumulative core burnup applicability limits for the existing North Anna Units 1 and 2 LTOPS setpoints and LTOPS T_{enable} values is accommodated by the margin provided by ASME Section XI Code Case N-640 and a plant-specific application of the T_{enable} analysis methodology that supports ASME Section XI Code Case N-514. The following is provided to support this conclusion that the proposed changes do not create a significant hazards consideration.

1. Does the change involve a significant increase in the probability or consequences of an accident previously evaluated

   The proposed changes modify the North Anna Units 1 and 2 RCS P/T limit curves and extend the cumulative core burnup applicability limits for the existing LTOPS setpoints and T_{enable} values. The allowable operating pressures and temperatures under the proposed RCS P/T limit curves are not significantly different from those allowed under the existing Technical Specification P/T limits. No changes to plant systems, structures, or components are proposed, and no new allowable operating modes are established. The P/T limits, LTOPS setpoints, and T_{enable} values do not contribute to the probability of occurrence or consequences of accidents previously analyzed. The revised licensing basis analyses utilize acceptable analytical methods, and continue to demonstrate that established accident analysis acceptance criteria are met. Therefore, there is no increase in the probability or consequences of any accident previously evaluated.

2. Does the change create the possibility of a new or different kind of accident from any accident previously evaluated

   The proposed changes modify the North Anna Units 1 and 2 RCS P/T limit curves, and extend the cumulative core burnup applicability of the existing LTOPS setpoints and T_{enable} values. No changes to plant systems, structures, or components are proposed, and no new allowable operating modes are established. Therefore, the proposed changes do not create the possibility of any accident or malfunction of a different type previously evaluated.

3. Does the change involve a significant reduction in the margin of safety

   The proposed revised RCS P/T limit curves, and revised LTOPS setpoint and T_{enable} analysis bases do not involve a significant reduction in the margin of safety for these parameters. The proposed revised RCS P/T limit curves use the ASME Section XI Code Case N-640 K_{1c} stress intensity formulation. The proposed revised LTOPS T_{enable} analysis bases use a plant-specific application of the analysis methodology that supports ASME Section XI Code Case N-514. These analysis features are less restrictive than those associated with the existing analyses, but are conservative with respect to requirements established by ASME Section XI. The effects of RCS pressure and temperature measurement uncertainty are considered in the supporting analyses. The proposed revised RCS P/T limit curves are valid to cumulative core burnups of 32.3 EFPY and 34.3 EFPY for North Anna Units 1 and 2, respectively. The proposed revised LTOPS setpoint and T_{enable} analyses support continued use of the existing North Anna Units 1 and 2 Technical Specification LTOPS setpoints and LTOPS enable temperatures to these same cumulative core burnup limits. The analyses demonstrate that established analysis acceptance criteria continue to be met. Specifically, the existing P/T limit curves, LTOPS setpoints, and LTOPS T_{enable} values provide acceptable margin to vessel fracture under both normal operation and LTOPS design basis (mass addition and heat addition) accident conditions. Therefore, the proposed changes do not result in a significant reduction in a margin of safety.

Attachment 5

Backup Information to Support Heatup and Cooldown Curves Documented in WCAP-15112, Rev. 1

North Anna Power Station
Units 1 and 2
Virginia Electric and Power Company
(Dominion)

TABLE 1
Data for 100°F/hr Cooldown Curve

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	K_{IT} (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
545	0.9599	545.17	549.08	549.97
540	2.4083	540.18	546.62	549.76
535	3.6946	535.26	543.62	549.18
530	4.9270	530.27	540.41	548.17
525	6.0093	525.33	536.92	546.76
520	7.0051	520.33	533.31	544.98
515	7.8796	515.38	529.52	542.86
510	8.6761	510.39	525.62	540.45
505	9.3761	505.43	521.59	537.76
500	10.0104	500.43	517.46	534.83
495	10.5674	495.46	513.23	531.67
490	11.0701	490.46	508.93	528.31
485	11.5104	485.49	504.54	524.77
480	11.9063	480.49	500.08	521.07
475	12.2515	475.51	495.56	517.23
470	12.5606	470.51	490.99	513.25
465	12.8285	465.53	486.36	509.15
460	13.0671	460.53	481.69	504.95
455	13.2722	455.54	476.98	500.64
450	13.4537	450.54	472.23	496.25
445	13.6077	445.56	467.45	491.79
440	13.7429	440.55	462.64	487.25
435	13.8556	435.56	457.80	482.65
430	13.9532	430.56	452.93	477.99
425	14.0325	425.57	448.05	473.27
420	14.0998	420.56	443.14	468.52
415	14.1521	415.57	438.22	463.72
410	14.1948	410.57	433.28	458.88

TABLE 1 (continued)
Data for 100°F/hr Cooldown Curve

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	K_{IT} (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
405	14.2253	405.58	428.33	454.01
400	14.2483	400.57	423.36	449.11
395	14.2612	395.58	418.39	444.18
390	14.2682	390.57	413.39	439.23
385	14.2670	385.58	408.40	434.25
380	14.2614	380.57	403.40	429.26
375	14.2488	375.58	398.38	424.24
370	14.2329	370.57	393.36	419.22
365	14.2113	365.58	388.34	414.17
360	14.1872	360.57	383.31	409.12
355	14.1585	355.58	378.27	409.05
350	14.1278	350.57	373.23	398.98
345	14.0933	345.58	368.19	393.89
340	14.0575	340.57	363.14	388.80
335	14.0185	335.58	358.09	383.70
330	13.9785	330.57	353.04	378.59
325	13.9359	325.58	347.99	373.48
320	13.8928	320.57	342.93	368.37
315	13.8474	315.57	337.87	363.24
310	13.8017	310.57	332.81	358.12
305	13.7541	305.57	327.75	352.99
300	13.7065	300.56	322.69	347.86
295	13.6573	295.57	317.62	342.72
290	13.6081	290.56	312.56	337.59
285	13.5576	285.57	307.49	332.45
280	13.5073	280.56	302.42	327.31
275	13.4558	275.56	297.36	322.16
270	13.4047	270.56	292.29	317.02

TABLE 1 (continued)
Data for 100°F/hr Cooldown Curve

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	K_{IT} (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
265	13.3525	265.56	287.22	311.87
260	13.3007	260.56	282.15	306.73
255	13.2480	255.56	277.08	301.58
250	13.1958	250.55	272.01	296.43
245	13.1427	245.56	266.94	291.29
240	13.0902	240.55	261.87	286.14
235	13.0370	235.55	256.80	280.99
230	12.9843	230.55	251.73	275.84
225	12.9309	225.55	246.66	270.69
220	12.8781	220.55	241.59	265.54
215	12.8247	215.55	236.52	260.39
210	12.7719	210.54	231.45	255.24
205	12.7186	205.55	226.37	250.09
200	12.6658	200.54	221.30	244.93
195	12.6125	195.54	216.23	239.78
190	12.5598	190.54	211.16	234.63
185	12.5067	185.54	206.09	229.48
180	12.4541	180.54	201.02	224.33
175	12.4011	175.54	195.95	219.18
170	12.3487	170.53	190.88	214.03
165	12.2959	165.54	185.81	208.88
160	12.2436	160.53	180.74	203.73
155	12.1910	155.53	175.67	198.58
150	12.1389	150.53	170.60	193.43
145	12.0865	145.53	165.53	188.28
140	12.0346	140.53	160.46	183.14
135	11.9824	135.53	155.39	177.99

TABLE 1 (continued)
Data for 100°F/hr Cooldown Curve

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	K_{IT} (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
130	11.9308	130.52	150.32	172.84
125	11.8788	125.53	145.25	167.69
120	11.8274	120.52	140.18	162.54
115	11.7756	115.52	135.11	157.39
110	11.7244	110.52	130.04	152.25
105	11.6729	105.52	124.97	147.10
100	11.6219	100.52	119.90	141.95
95	11.5706	95.52	114.83	136.81
90	11.5199	90.51	109.76	131.66
85	11.4689	85.52	104.70	126.51
80	11.4183	80.51	99.63	121.37
75	11.3676	75.51	94.56	116.22
70	11.3173	70.51	89.49	111.08
65	11.2667	65.51	84.42	105.72
60	11.2159	60.51	79.36	100.79
55	11.1641	55.51	74.29	95.64

TABLE 2
Data for 60°F/hr Heatup Curve – ¼T Location

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
75	-1.0634	74.87	71.62	70.20
80	-2.3438	79.87	75.05	71.09
85	-3.2124	84.81	78.63	72.90
90	-3.9690	89.81	82.57	75.41
95	-4.5150	94.77	86.74	78.45
100	-4.9808	99.77	91.06	81.91
105	-5.3242	104.74	95.55	85.69
110	-5.6179	109.75	100.12	89.72
115	-5.8371	114.72	104.80	93.95
120	-6.0278	119.73	109.51	98.33
125	-6.1715	124.71	114.31	102.83
130	-6.2998	129.72	119.12	107.42
135	-6.3977	134.71	123.98	112.08
140	-6.4882	139.71	128.85	116.80
145	-6.5584	144.70	133.75	121.56
150	-6.6258	149.71	138.65	126.36
155	-6.6920	154.70	143.57	131.18
160	-6.7324	159.71	148.50	136.03
165	-6.7757	164.70	153.44	140.89
170	-6.8201	169.70	158.38	145.89
175	-6.8573	174.69	163.33	150.64
180	-6.8964	179.70	168.27	155.53
185	-6.9299	184.69	173.23	160.43
190	-6.9657	189.70	178.18	165.33
195	-6.9970	194.69	183.13	170.23
200	-7.0307	199.70	188.09	175.14

TABLE 2 (continued)
Data for 60˚F/hr Heatup Curve – ¼T Location

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5˚F	
Water Temperature (˚F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (˚F)	¼T Temperature (˚F)	¾T Temperature (˚F)
205	-7.0608	204.69	193.05	180.05
210	-7.0933	209.70	198.00	184.96
215	-7.1227	214.69	202.96	189.87
220	-7.1543	219.69	207.92	194.79
225	-7.1834	224.69	212.88	199.70
230	-7.2145	229.69	217.84	204.62
235	-7.2435	234.69	222.80	209.53
240	-7.2744	239.69	227.76	214.45
245	-7.3032	244.68	232.72	219.36
250	-7.3340	249.69	237.68	224.28
255	-7.3629	254.68	242.64	229.19
260	-7.3936	259.69	247.60	234.11
265	-7.4226	264.68	252.56	239.03
270	-7.4533	269.69	257.52	243.94
275	-7.4825	274.68	262.48	248.86
280	-7.5132	279.68	267.44	253.77
285	-7.5425	284.68	272.40	258.69
290	-7.5732	289.68	277.36	263.61
295	-7.6026	294.68	282.32	268.52
300	-7.6334	299.68	287.28	273.87
305	-7.6630	304.68	292.24	278.35
310	-7.6939	309.68	297.20	283.27
315	-7.7236	314.67	302.16	288.18
320	-7.7546	319.68	307.11	293.10
325	-7.7845	324.67	312.07	298.01
330	-7.8155	329.68	317.03	302.93

TABLE 2 (continued)
Data for 60°F/hr Heatup Curve – ¼T Location

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
335	-7.8455	334.67	321.99	307.84
340	-7.8766	339.68	326.95	312.76
345	-7.9069	344.67	331.91	317.67
350	-7.9381	349.67	336.87	322.58
355	-7.9684	354.70	341.83	327.50
360	-7.9997	359.67	346.79	332.41
365	-8.0302	364.67	351.75	337.33
370	-8.0616	369.67	356.70	342.24
375	-8.0923	374.67	361.66	347.15
380	-8.1238	379.67	371.36	352.07
385	-8.1546	384.67	376.34	356.98
390	-8.1862	389.67	381.33	361.89
395	-8.2172	394.66	386.28	366.80
400	-8.2489	399.67	391.23	371.72
405	-8.2800	404.66	396.23	376.63
410	-8.3118	409.67	401.20	381.54
415	-8.3430	414.66	406.17	386.45
420	-8.3750	419.66	411.15	391.37
425	-8.4063	424.66	416.12	396.28
430	-8.4384	429.66	421.09	401.19
435	-8.4699	434.66	426.07	406.10
440	-8.5021	439.66	431.04	411.01
445	-8.5337	444.66	436.01	415.92
450	-8.5660	449.66	440.98	420.83
455	-8.5978	454.66	445.96	425.74
460	-8.6302	459.66	450.93	430.65

TABLE 2 (continued)
Data for 60°F/hr Heatup Curve – ¼T Location

Flaw Location = ¼T		50.3 EFPY	RT_{NDT} = 218.5°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	¼T Temperature (°F)	¾T Temperature (°F)
465	-8.6621	464.65	455.90	435.56
470	-8.6946	469.66	460.87	440.47
475	-8.7267	474.65	465.85	445.39
480	-8.7593	479.66	470.82	450.29
485	-8.7915	484.65	475.79	455.20
490	-8.8243	489.65	480.76	460.11
495	-8.8566	494.65	485.73	465.02
500	-8.8895	499.65	490.71	469.93
505	-8.9219	504.65	495.68	474.84
510	-8.9549	509.65	500.65	479.75
515	-8.9875	514.65	505.62	484.66
520	-9.0206	519.65	510.59	489.57
525	-9.0534	524.65	515.57	494.48
530	-9.0866	529.65	520.54	499.38
535	-9.1195	534.65	525.51	504.29
540	-9.1528	539.65	530.48	509.20
545	-9.1859	544.64	535.45	514.11
550	-9.2193	549.65	540.42	519.02

TABLE 3
Data for 60°F/hr Heatup Curve – ¾T Location

Flaw Location = 3/4T		50.3 EFPY	RT_{NDT} = 195.6°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	1/4 T Temperature (°F)	3/4 T Temperature (°F)
75	0.6079	74.87	71.62	70.20
80	1.5967	79.87	75.05	71.09
85	2.3228	84.81	78.63	72.90
90	2.9047	89.81	82.57	75.41
95	3.3546	94.77	86.74	78.45
100	3.7149	99.77	91.06	81.91
105	3.9961	104.74	95.55	85.69
110	4.2232	109.75	100.12	89.72
115	4.4024	114.72	104.80	93.95
120	4.5490	119.73	109.51	98.33
125	4.6666	124.71	114.31	102.83
130	4.7644	129.72	119.12	107.42
135	4.8446	134.71	123.98	112.08
140	4.9129	139.71	128.85	116.80
145	4.9703	144.70	133.75	121.56
150	5.0206	149.71	138.65	126.36
155	5.0642	154.70	143.57	131.18
160	5.1036	159.71	148.50	136.03
165	5.1388	164.70	153.44	140.89
170	5.1715	169.70	158.38	145.89
175	5.2015	174.69	163.33	150.64
180	5.2302	179.70	168.27	155.53
185	5.2571	184.69	173.23	160.43
190	5.2832	189.70	178.18	165.33
195	5.3082	194.69	183.13	170.23
200	5.3329	199.70	188.09	175.14

TABLE 3 (continued)
Data for 60°F/hr Heatup Curve – ¾T Location

Flaw Location = 3/4T		50.3 EFPY	RT_{NDT} = 195.6°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	1/4 T Temperature (°F)	3/4 T Temperature (°F)
205	5.3568	204.69	193.05	180.05
210	5.3805	209.70	198.00	184.96
215	5.4037	214.69	202.96	189.87
220	5.4270	219.69	207.92	194.79
225	5.4498	224.69	212.88	199.70
230	5.4827	229.69	217.84	204.62
235	5.4954	234.69	222.80	209.53
240	5.5181	239.69	227.76	214.45
245	5.5407	244.68	232.72	219.36
250	5.5633	249.69	237.68	224.28
255	5.5859	254.68	242.64	229.19
260	5.6086	259.69	247.60	234.11
265	5.6311	264.68	252.56	239.03
270	5.6538	269.69	257.52	243.94
275	5.6765	274.68	262.48	248.86
280	5.6992	279.68	267.44	253.77
285	5.7219	284.68	272.40	258.69
290	5.7447	289.68	277.36	263.61
295	5.7675	294.68	282.32	268.52
300	5.7904	299.68	287.28	273.87
305	5.8132	304.68	292.24	278.35
310	5.8362	309.68	297.20	283.27
315	5.8591	314.67	302.16	288.18
320	5.8822	319.68	307.11	293.10
325	5.9052	324.67	312.07	298.01
330	5.9284	329.68	317.03	302.93
335	5.9515	334.67	321.99	307.84

TABLE 3 (continued)
Data for 60°F/hr Heatup Curve – ¾T Location

Flaw Location = 3/4T		50.3 EFPY	RT_{NDT} = 195.6°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	1/4 T Temperature (°F)	3/4 T Temperature (°F)
340	5.9747	339.68	326.95	312.76
345	5.9979	344.67	331.91	317.67
350	6.0212	349.67	336.87	322.58
355	6.0446	354.70	341.83	327.50
360	6.0680	359.67	346.79	332.41
365	6.0914	364.67	351.75	337.33
370	6.1149	369.67	356.70	342.24
375	6.1384	374.67	361.66	347.15
380	6.1620	379.67	371.36	352.07
385	6.1856	384.67	376.34	356.98
390	6.2093	389.67	381.33	361.89
395	6.2330	394.66	386.28	366.80
400	6.2567	399.67	391.23	371.72
405	6.2805	404.66	396.23	376.63
410	6.3044	409.67	401.20	381.54
415	6.3283	414.66	406.17	386.45
420	6.3523	419.66	411.15	391.37
425	6.3763	424.66	416.12	396.28
430	6.4003	429.66	421.09	401.19
435	6.4244	434.66	426.07	406.10
440	6.4485	439.66	431.04	411.01
445	6.4727	444.66	436.01	415.92
450	6.4970	449.66	440.98	420.83
455	6.5213	454.66	445.96	425.74
460	6.5456	459.66	450.93	430.65
465	6.5700	464.65	455.90	435.56

TABLE 3 (continued)
Data for 60°F/hr Heatup Curve – ¾T Location

Flaw Location = 3/4T		50.3 EFPY	RT_{NDT} = 195.6°F	
Water Temperature (°F)	Kit (KSI SQ. RT. IN.)	Surface Temperature (°F)	1/4 T Temperature (°F)	3/4 T Temperature (°F)
470	6.5944	469.66	460.87	440.47
475	6.6189	474.65	465.85	445.39
480	6.6434	479.66	470.82	450.29
485	6.6680	484.65	475.79	455.20
490	6.6926	489.65	480.76	460.11
495	6.7173	494.65	485.73	465.02
500	6.7420	499.65	490.71	469.93
505	6.7667	504.65	495.68	474.84
510	6.7916	509.65	500.65	479.75
515	6.8164	514.65	505.62	484.66
520	6.8413	519.65	510.59	489.57
525	6.8663	524.65	515.57	494.48
530	6.8913	529.65	520.54	499.38
535	6.9164	534.65	525.51	504.29
540	6.9415	539.65	530.48	509.20
545	6.9666	544.64	535.45	514.11
550	6.9918	549.65	540.42	519.02