VOGTLE ELECTRIC GENERATING PLA - UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT

REVISION 0

[DATE]

VOGTLE ELECTRIC GENERATING PLANT (VEGP) - UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT

Table of Contents

List of Figures

VOGTLE ELECTRIC GENERATING PLANT (VEGP) - UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT

List of Tables

VOGTLE ELECTRIC GENERATING PLANT (VEGP) - UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT

1.0 Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR) - Unit 1

This PTLR for VEGP Unit 1 has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.6. The TS addressed in this report are listed below:

LCO 3.4.3 RCS Pressure and Temperature (P/T) Limits

LCO 3.4.12 Cold Overpressure Protection Systems (COPS)

2.0 Operating Limits

The parameter limits for the specifications listed in section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodology specified in Specification 5.6.6 (Ref. 1).

2.1 RCS Pressure and Temperature (P/T) Limits (LCO 3.4.3)

2.1.1 The RCS temperature rate-of-change limits are (Ref. 2):

a. A maximum heatup of 100 ^{0}F in any 1-hour period.

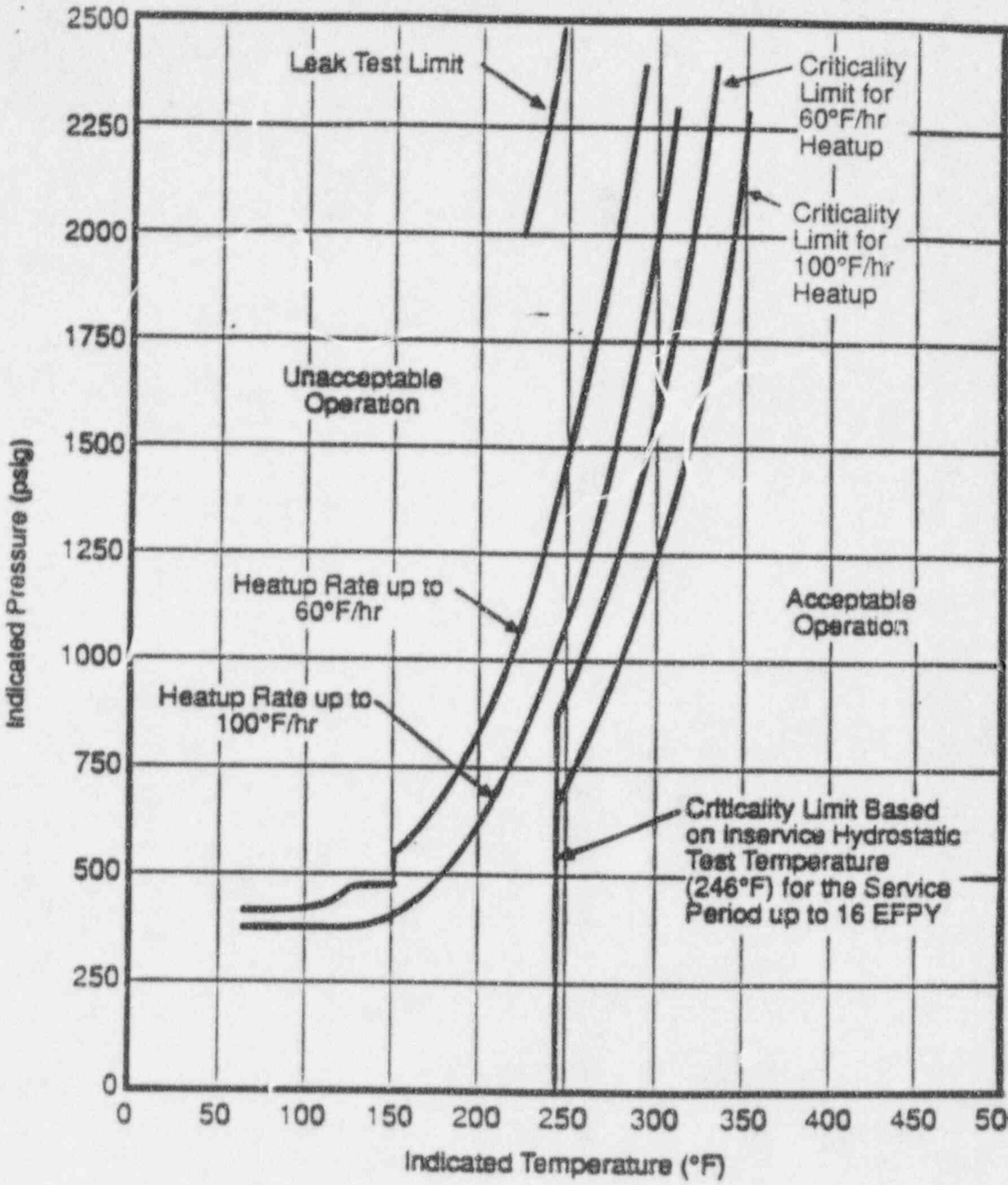
b. A maximum cooldown of 100 ^{0}F in any 1-hour period

c. A maximum temperature change of less than or equal to 10 ^{0}F in any 1-hour period during inservice hydrostatic and leak testing operations above the heatup and cooldown limit curves.

2.1.2 The RCS P/T limits for heatup and cooldown are specified by Figures 2.1-1 and 2.1-2, respectively.

2.2 Cold Overpressure Protection System (COPS) Setpoints (LCO 3.4.12)

The power-operated relief valves (PORVs) shall each have lift settings in accordance with Figure 2.2-1.

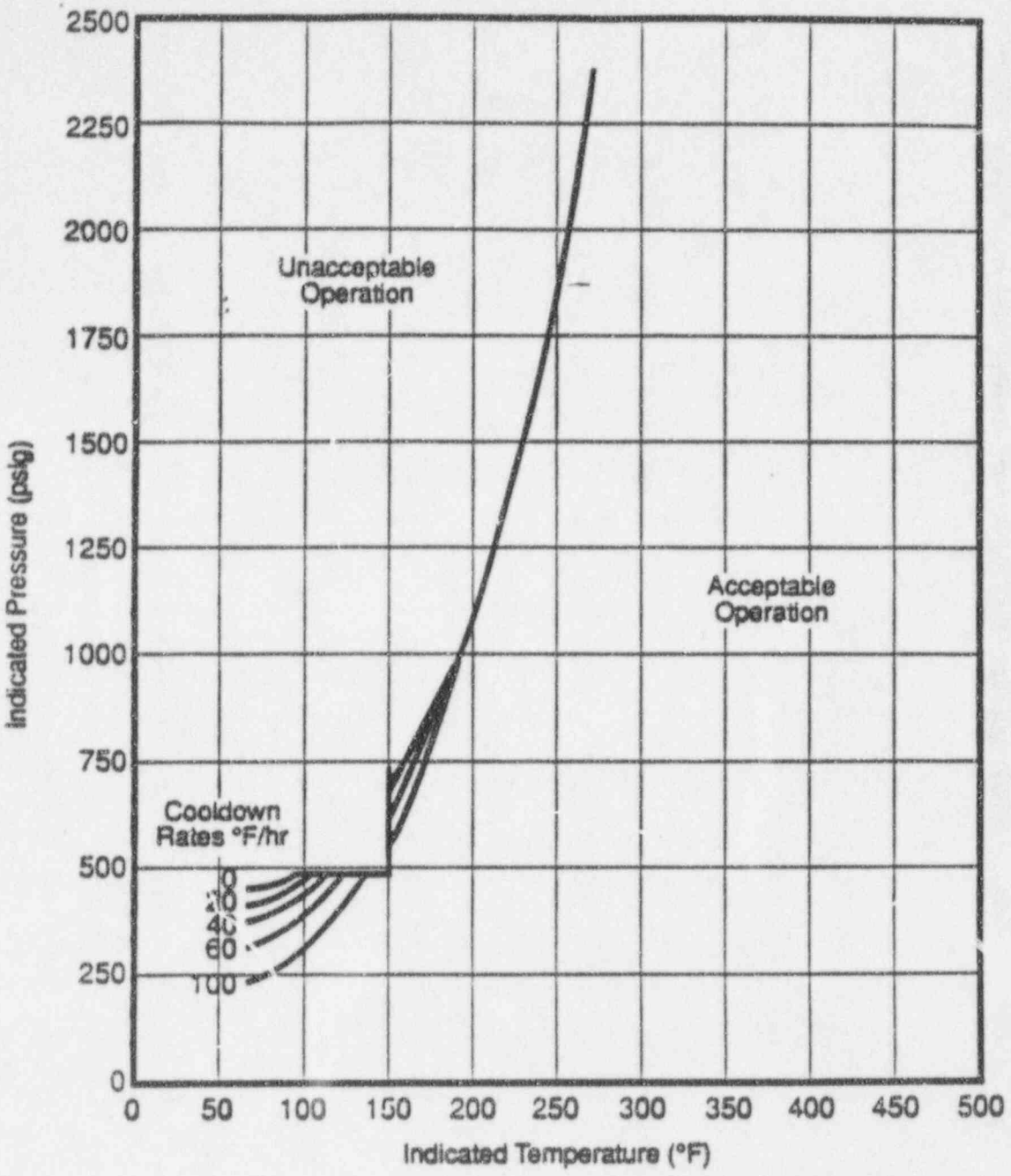


MATERIAL BASIS

Copper Content:	Assumed - NA WT% (Actual - 0.083 WT%)
RT_{NDT} Initial:	Assumed - NA °F (Actual - 20°F)
RT_{NDT} At 16 EFPY:	@ 1/4T = 100.7°F @ 3/4T = 84.1°F

Figure ~~3/4 4-2a~~ 2.1-1

Unit 1 Reactor Coolant System Heatup Limitations (Heatup rates up to 100°F/hr) Applicable for the First 16 EFPY (With Margins of 10°F and 60 psig for Instrumentation Errors and Margin of 74 psig for Pressure Difference Between Pressure Instrumentation and Reactor Vessel Beltline Region).



MATERIAL BASIS

Copper Content:	Assumed - NA WT% (Actual - 0.083 WT%)
RT_{NDT} Initial:	Assumed - NA °F (Actual - 20°F)
RT_{NDT} At 16 EFPY:	@ 1/4T = 100.7°F @ 3/4T = 84.1°F

Figure ~~3.4-3a~~ 2.1-2

Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable for the First 16 EFPY (With Margins of 10°F and 60 psig for Instrumentation Errors and Margin of 74 psig for Pressure Difference Between Pressure Instrumentation and Reactor Vessel Beltline Region).

Amendment No. 87 (Unit 1)
Amendment No. 65 (Unit 2)

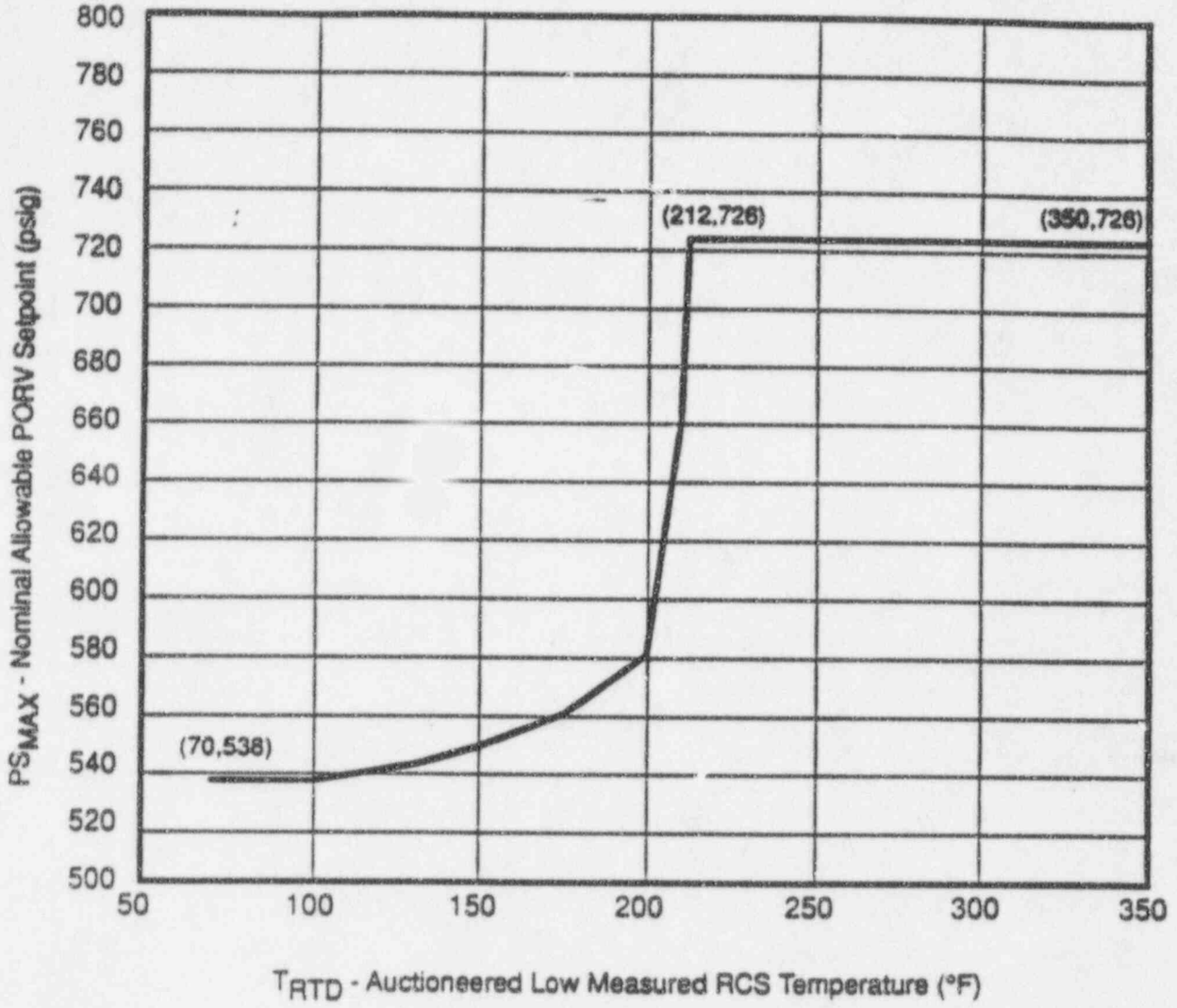


Figure ~~3.4-1a~~ 2.2-1
Unit 1 Maximum Allowable Nominal PORV Setpoint for
the Cold Overpressure Protection System

3.0 Supplemental Data Tables

Table 3.0-1 is a comparison of the measured surveillance material 30 ft-lb transition temperature shifts and upper shelf energy decreases with Regulatory Guide 1.99, Revision 2 predictions.

Table 3.0-2 shows the calculation of the surveillance material chemistry factors using surveillance capsule data.

Table 3.0-3 provides the unirradiated Vogtle Unit 1 reactor vessel toughness data. The bolt-up temperature is also included in this table.

Table 3.0-4 provides a summary of the fluences used in the generation of the heatup and cooldown curves.

Table 3.0-5 provides a summary of the adjusted reference temperatures (ARTs) of the Vogtle Unit 1 reactor vessel beltline materials at the 1/4-T and 3/4-T locations for 16 EFPY.

Table 3.0-6 shows the calculation of the ART at 16 EFPY for the limiting Vogtle Unit 1 reactor vessel material (intermediate shell plate B8805-2).

Table 3.0-7 provides a summary of the fluences used in the PTS evaluation.

Table 3.0-8 provides RT_{PTS} values for Vogtle Unit 1 for 4.64 EFPY.

Table 3.0-9 provides RT_{PTS} values for Vogtle Unit 1 for 32 EFPY.

Table 3.0-10 provides RT_{PTS} values for Vogtle Unit 1 for 48 EFPY.

Table 3.0-1

Comparison of the Vogtle Unit 1 Surveillance Material 30 ft-lb Transition Temperature Shifts and Upper Shelf Energy Decrease with Regulatory Guide 1.99 Revision 2 Predictions

Material	Capsule	Fluence ($\times 10^{19}$ n/cm^2, E > 1.0 MeV)	30 ft-lb Transition Temperature Shift		Upper Shelf Energy Decrease	
			Predicted[a] (°F)	Measured (°F)	Predicted[a] (%)	Measured[a] (%)
Intermediate Shell Plate B8805-3 (Longitidinal)	U	0.344	27	15	15	0
	Y	1.24	41	40	20	0
Intermediate Shell Plate B8805-3 (Transverse)	U	0.344	27	0	15	0
	Y	1.24	41	20	20	0
Weld Metal	U	0.344	23	15	15	0
	Y	1.24	35	0	20	1
HAZ Metal	U	0.344	-	0	-	6
	Y	1.24	-	25	-	9

(a) Based on Regulatory Guide 1.99, Revision 2, methodology using mean wt. % values of Cu and Ni.

Table 3.0-2

Vogtle Unit 1
Calculation of Chemistry Factors Using Surveillance Capsule Data

Material	Capsule	Fluence (f) (n/cm^2, $E > 1.0$ MeV)	FF[(a)]	ΔRT_{NDT} (°F)	$FF*\Delta RT_{NDT}$ (°F)	FF^2
Intermediate Shell Plate B8805-3 (Longitudinal)	U	3.437×10^{18}	0.706	15	10.585	0.498
	Y	1.242×10^{19}	1.060	40	42.4	1.124
Intermediate Shell Plate B8805-3 (Transverse)	U	3.437×10^{18}	0.706	0	0	0.498
	Y	1.242×10^{19}	1.060	20	21.2	1.124
				Sum:	74.185	3.244
	Chemistry Factor = 74.185 ÷ 3.244 = 22.9					
Weld Metal	U	3.437×10^{18}	0.706	15	10.585	0.498
	Y	1.242×10^{19}	1.060	0	0	1.124
				Sum:	10.585	1.622
	Chemistry Factor = 10.585 ÷ 1.622 = 6.5					

(a) Fluence Factor (FF) per Regulatory Guide 1.99, Revision 2, is defined as $FF = f^{(0.28 - 0.10 \log f)}$

Table 3.0-3			
Vogtle Unit 1 Reactor Vessel Toughness Table (Unirradiated)			
Material Description	Cu (%)[a]	Ni (%)[a]	Initial RT_{NDT} (°F)[b]
Closure Head Flange	- -	0.70	20[c]
Vessel Flange	- -	0.71	0[c]
Intermediate Shell Plate B8805-1	0.083	0.597	0
Intermediate Shell Plate B8805-2	0.083	0.610	20
Intermediate Shell Plate B8805-3	0.062	0.598	30
Lower Shell Plate B8606-1	0.053	0.593	20
Lower Shell Plate B8606-2	0.057	0.600	20
Lower Shell Plate B8606-3	0.067	0.623	10
Intermediate & Lower Shell Vertical Weld Seams and Girth Seam Weld	0.039	0.102	-80

(a) The average values of copper and nickel content.

(b) Initial RT_{NDT} values are measured values.

(c) These values are used for considering flange requirements for the heatup/cooldown curves. Per the methodology given in WCAP-14040, Revision 1, the minimum boltup temperature is 60 °F.

Table 3.0-4						
Vogtle Unit 1 Reactor Vessel Surface Fluence Values at 16 EFF Y (Fluence Based on E > 1.0 MeV)						
Azimuthal	0°	15°	25°	30°	45°	45°
Surface	6.216E+18	9.236E+18	1.088E+19	6.897E+18	9.043E+18	1.015E+19

Table 3.0-5

Summary of Adjusted Reference Temperatures (ARTs) for the Vogtle Unit 1 Reactor Vessel Beltline Materials at the 1/4-T and 3/4-T Locations for 16 EFPY

Component	16 EFPY ART[a]	
	1/4-T (°F)	3/4-T (°F)
Intermediate Shell Plate B8805-1	80.7	64.1
Intermediate Shell Plate B8805-2	100.7[b]	84.1[b]
Intermediate Shell Plate B8805-3	97.5	76.4
Intermediate Shell Plate B8805-3 Using S/C Data	67.1	57.6
Lower Shell Plate B8606-1	77.6	59.6
Lower Shell Plate B8606-2	81.9	62.5
Lower Shell Plate B8606-3	80.8	60.6
Circ. Weld 101-171	-21.7	-39.9
Circ. Weld 101-171 Using S/C Data	-68.6	-72.2
Long. Weld 101-124A	-31.8[c]	-48.5[c]
Long. Weld 101-124B	-30.0[d]	-47.0[d]
Long. Weld 101-124C	-30.0[d]	-47.0[d]
Long. Weld 101-142A	-30.0[d]	-47.0[d]
Long. Weld 101-142B	-31.8[c]	-48.5[c]
Long. Weld 101-142C	-30.0[d]	-47.0[d]

(a) The ARTs presented here are based on the peak reactor vessel surface fluence of 1.088×10^{19} n/cm^2 (E > 1.0 MeV) unless noted.

(b) These ART values are used to generate the heatup and cooldown curves.

(c) These ARTs were calculated using the peak vessel fluence of 6.216×10^{18} n/cm^2 (E > 1.0 MeV) at 0°.

(d) These ARTs were calculated using the peak vessel fluence of 6.897×10^{18} n/cm^2 (E > 1.0 MeV) at 30°.

Table 3.0-6		
Calculation of Adjusted Reference Temperature at 16 EFPY for the Limiting Vogtle Unit 1 Reactor Vesel Material (Intermediate Shell Plate B8805-2)		
Parameter	ART Value	
Operating Time	16 EFPY	
Material	B8805-2	B8805-2
Location	1/4-T	3/4-T
Chemistry Factor, CF (°F)	53.1	53.1
Fluence $\times 10^{19}$ n/cm^2 (E > 1.0 MeV), f[a]	0.6485	0.2303
Fluence Factor, FF[b]	0.879	0.604
ΔRT_{NDT} = CF x FF, (°F)	46.653	32.056
Initial RT_{NDT}, I (°F)	20	20
Margin, M (°F)[c]	34	32.056
ART = I + (CF x FF) + M (°F) per Regulatory Guide 1.99, Revision 2	100.7	84.1

(a) Fluence, f, is based upon f_{surf} (10^{19} n/cm^2, E > 1.0 MeV) = 1.088 at 16 EFPY. The Vogtle Unit 1 reactor vessel wall thickness is 8.625 inches at the beltline region.

(b) Fluence Factor (FF) per Regulatory Guide 1.99, Revision 2, is defined as $FF = f^{(0.28 - 0.10 \log f)}$.

(c) Margin is calculated as $M = 2(\sigma_i^2 + \sigma_\Delta^2)^{0.5}$. The standard deviation for the initial RT_{NDT} margin term, σ_i, is 0 °F since the initial RT_{NDT} is a measured value. The Standard deviation for ΔRT_{NDT} term σ_Δ, is 17 °F for the plate, except that σ_Δ need not exceed 0.5 times the mean value of ΔRT_{NDT}.

Table 3.0-7						
Neutron Exposure Projections(1) at Key Locations on the Vogtle Unit 1 Pressure Vessel Clad/Base Metal Interface						
EFPY	0°	15°	25°	30°	35°	45°
4.64	0.1802	0.2678	0.3155	0.2000	0.2622	0.2942
32	1.243	1.847	2.176	1.379	1.809	2.029
48	1.863	2.769	3.262	2.068	2.711	3.041

(1) Fluence in 10^{19} n/cm^2 (E > 1.0 MeV).

Table 3.0-8

RT_{PTS} Values for Vogtle Unit 1 for 4.64 EFPY

Material	CF (°F)	Surface Fluence (n/cm², E > 1.0 MeV)	FF	ΔRT_{NDT} (CF x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Plate B8805-1	53.1	3.155×10^{18}	0.6833	36.3	0	34	70.3
Inter. Shell Plate B8805-2	53.1	3.155×10^{18}	0.6833	36.3	20	34	90.3
Inter. Shell Plate B8805-3	38.4	3.155×10^{18}	0.6833	26.2	30	34	90.2
Inter. Shell Plate B8805-3 Using S/C Data(1)	22.9	3.155×10^{18}	0.6833	15.6	30	34	79.6
Lower Shell Plate B8606-1	32.8	3.155×10^{18}	0.6833	22.4	20	34	76.4
Lower Shell Plate B8606-2	35.2	3.155×10^{18}	0.6833	24.1	20	34	78.1
Lower Shell Plate B8606-3	41.9	3.155×10^{18}	0.6833	28.6	10	34	72.6
Circ. Weld 101-171	33.2	3.155×10^{18}	0.6833	22.7	-80	56	-1.3
Weld Metal Using S/C Data(1)	6.5	3.155×10^{18}	0.6833(2)	4.4	-80	56	-19.6
Long. Weld 101-124A	33.2	1.802×10^{18}	0.5448	18.1	-80	56	-5.9
Long. Weld 101-124B	33.2	2.0×10^{18}	0.5694	18.9	-80	56	-5.1
Long. Weld 101-124C	33.2	2.0×10^{18}	0.5694	18.9	-80	56	-5.1
Long. Weld 101-142A	33.2	2.0×10^{18}	0.5694	18.9	-80	56	-5.1
Long. Weld 101-142B	33.2	1.802×10^{18}	0.5448	18.1	-80	56	-5.9
Long. Weld 101-142C	33.2	2.0×10^{18}	0.5694	18.9	-80	56	-5.1

(1) Numbers were calculated using a chemistry factor (CF) based on surveillance capsule data.

(2) Peak fluence factor which represents most limiting case for weld metal.

Table 3.0-9

RT_{PTS} Values for Vogtle Unit 1 for 32 EFPY

Material	CF (°F)	Surface Fluence (n/cm², E > 1.0 MeV)	FF	ΔRT_{NDT} (CF x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Plate B8805-1	53.1	2.176×10^{19}	1.2110	64.3	0	34	98.3
Inter. Shell Plate B8805-2	53.1	2.176×10^{19}	1.2110	64.3	20	34	118.3
Inter. Shell Plate B8805-3	38.4	2.176×10^{19}	1.2110	46.5	30	34	110.5
Inter. Shell Plate B8805-3 Using S/C Data(1)	22.9	2.176×10^{19}	1.2110	27.7	30	34	91.7
Lower Shell Plate B8606-1	32.8	2.176×10^{19}	1.2110	39.7	20	34	93.7
Lower Shell Plate B8606-2	35.2	2.176×10^{19}	1.2110	42.6	20	34	96.6
Lower Shell Plate B8606-3	41.9	2.176×10^{19}	1.2110	50.7	10	34	94.7
Circ. Weld 101-171	33.2	2.176×10^{19}	1.2110	40.2	-80	56	16.2
Weld Metal Using S/C Data(1)	6.5	2.176×10^{19}	1.2110(2)	7.9	-80	56	-16.1
Long. Weld 101-124A	33.2	1.243×10^{19}	1.0606	35.2	-80	56	11.2
Long. Weld 101-124B	33.2	1.379×10^{19}	1.0893	36.2	-80	56	12.2
Long. Weld 101-124C	33.2	1.379×10^{19}	1.0893	36.2	-80	56	12.2
Long. Weld 101-142A	33.2	1.379×10^{19}	1.0893	36.2	-80	56	12.2
Long. Weld 101-142B	33.2	1.243×10^{19}	1.0606	35.2	-80	56	11.2
Long. Weld 101-142C	33.2	1.379×10^{19}	1.0893	36.2	-80	56	12.2

(1) Numbers were calculated using a chemistry factor (CF) based on surveillance capsule data.

(2) Peak fluence factor which represents most limiting case for weld metal.

Table 3.0-10

RT_{PTS} Values for Vogtle Unit 1 for 48 EFPY

Material	CF (°F)	Surface Fluence (n/cm², E > 1.0 MeV)	FF	ΔRT_{NDT} (CF x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Plate B8805-1	53.1	3.262×10^{19}	1.3104	69.6	0	34	103.6
Inter. Shell Plate B8805-2	53.1	3.262×10^{19}	1.3104	69.6	20	34	123.6
Inter. Shell Plate B8805-3	38.4	3.262×10^{19}	1.3104	50.3	30	34	114.3
Inter. Shell Plate B8805-3 Using S/C Data(1)	22.9	3.262×10^{19}	1.3104	30.0	30	34	94.0
Lower Shell Plate B8606-1	32.8	3.262×10^{19}	1.3104	43.0	20	34	97.0
Lower Shell Plate B8606-2	35.2	3.262×10^{19}	1.3104	46.1	20	34	100.1
Lower Shell Plate B8606-3	41.9	3.262×10^{19}	1.3104	54.9	10	34	98.9
Circ. Weld 101-171	33.2	3.262×10^{19}	1.3104	43.5	-80	56	19.5
Weld Metal Using S/C Data(1)	6.5	3.262×10^{19}	1.3104(2)	8.5	-80	56	-15.5
Long. Weld 101-124A	33.2	1.863×10^{19}	1.1705	38.9	-80	56	14.9
Long. Weld 101-124B	33.2	2.068×10^{19}	1.1978	39.8	-80	56	15.8
Long. Weld 101-124C	33.2	2.068×10^{19}	1.1978	39.8	-80	56	15.8
Long. Weld 101-142A	33.2	2.068×10^{19}	1.1978	39.8	-80	56	15.8
Long. Weld 101-142B	33.2	1.863×10^{19}	1.1705	38.9	-80	56	14.9
Long. Weld 101-142C	33.2	2.068×10^{19}	1.1978	39.8	-80	56	15.8

(1) Numbers were calculated using a chemistry factor (CF) based on surveillance capsule data.

(2) Peak fluence factor which represents most limiting case for weld metal.

4.0 Reactor Vessel Material Surveillance Program

The reactor vessel material surveillance program is in compliance with 10 CFR 50, Appendix H, and is described in section 16.3 of the VEGP FSAR.

5.0 References

1. WCAP-14040, Revision 1, December 1994, "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves.

2. Louis L. Wheeler to C. K. McCoy, dated June 8, 1995, "Issuance of Amendments - Vogtle Electric Generating Plant, Units 1 and 2 (TAC Nos. M90966 and M90967)."

VOGTLE ELECTRIC GENERATING PLANT - UNIT 2

PRESSURE AND TEMPERATURE LIMITS REPORT

REVISION 0

[DATE]

VOGTLE ELECTRIC GENERATING PLANT - UNIT 2

PRESSURE AND TEMPERATURE LIMITS REPORT

Table of Contents

List of Figures

VOGTLE ELECTRIC GENERATING PLANT - UNIT 2

PRESSURE AND TEMPERATURE LIMITS REPORT

List of Tables

VOGTLE ELECTRIC GENERATING PLANT (VEGP) - UNIT 2

PRESSURE AND TEMPERATURE LIMITS REPORT

1.0 Reactor Coolant System (RCS) Pressure and Temperature Limits Report (PTLR) - Unit 2

This PTLR for VEGP Unit 2 has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.6. The TS addressed in this report are listed below:

LCO 3.4.3 RCS Pressure and Temperature (P/T) Limits

LCO 3.4.12 Cold Overpressure Protection Systems (COPS)

2.0 Operating Limits

The parameter limits for the specifications listed in section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodology specified in Specification 5.6.6 (Ref. 1).

2.1 RCS Pressure and Temperature (P/T) Limits (LCO 3.4.3)

2.1.1 The RCS temperature rate-of-change limits are (Ref. 2):

a. A maximum heatup of 100 ^{0}F in any 1-hour period.

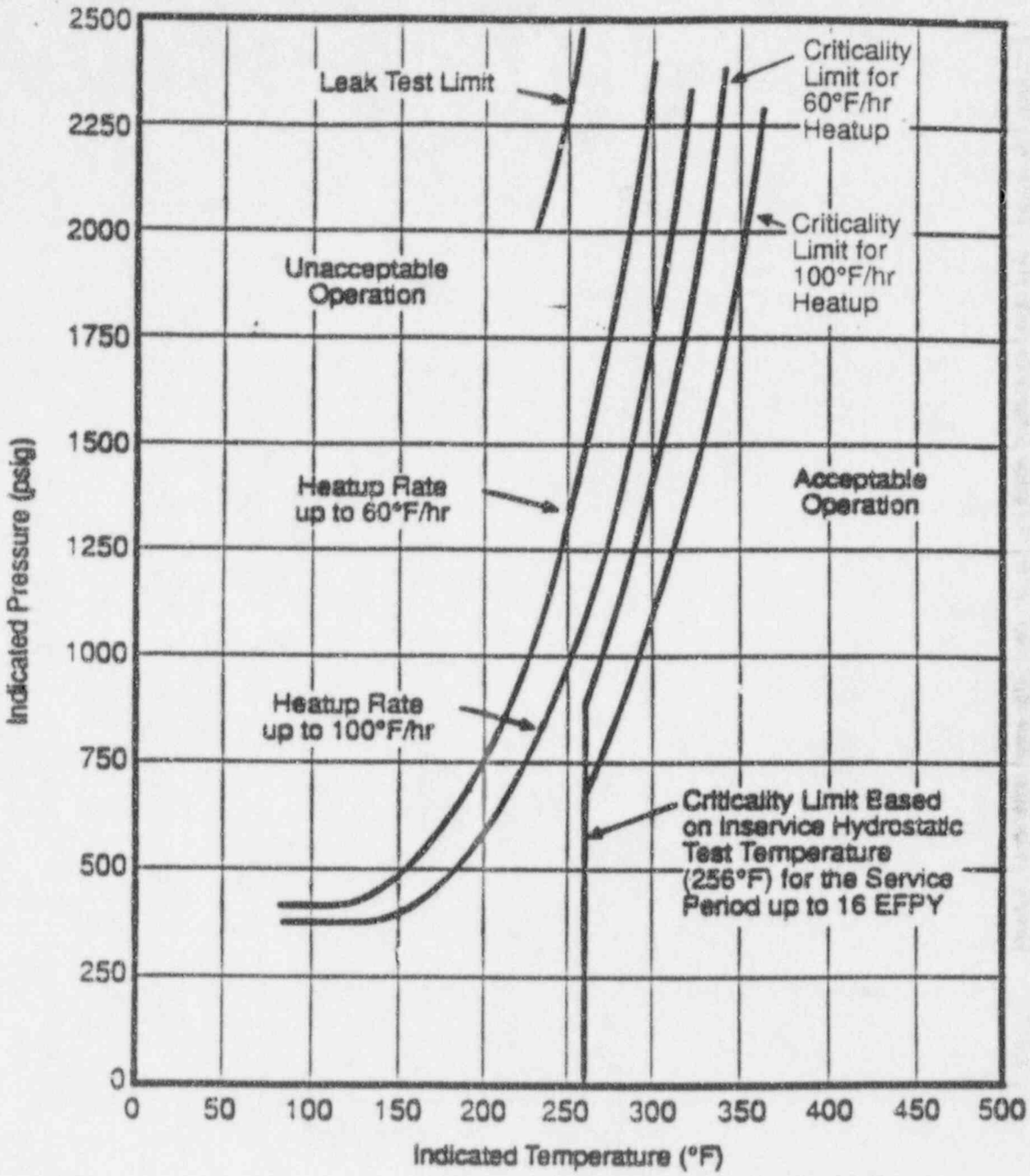
b. A maximum cooldown of 100 ^{0}F in any 1-hour period.

c. A maximum temperature change of less than or equal to 10 ^{0}F in any 1-hour period during inservice hydrostatic and leak testing operations above the heatup and cooldown limit curves.

2.1.2 The RCS P/T limits for heatup and cooldown are specified by Figures 2.1-1 and 2.1-2, respectively.

2.2 Cold Overpressure Protection System (COPS) Setpoints (LCO 3.4.12)

The power-operated relief valves (PORVs) shall each have lift settings in accordance with Figure 2.2-1.

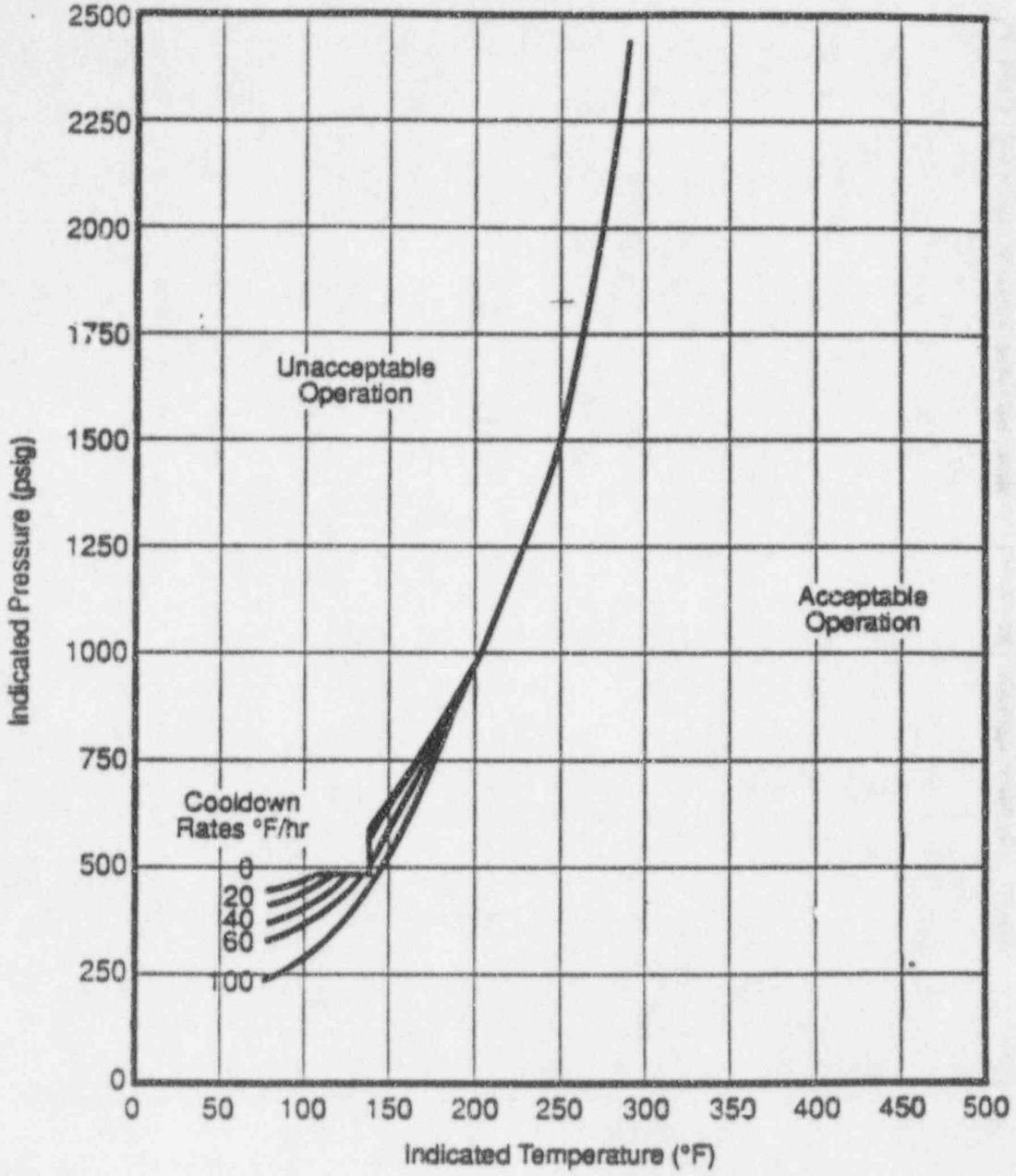


MATERIAL BASIS

Copper Content:	Assumed - NA WT% (Actual - 0.05 WT%)
RT_{NDT} Initial:	Assumed - NA °F (Actual - 50°F)
RT_{NDT} At 16 EFPY:	@ 1/4T = 112°F @ 3/4T = 94°F

Figure ~~3.4-3b~~ 2.1-1

Unit 2 Reactor Coolant System Heatup Limitations (Heatup rates up to 100°F/hr) Applicable for the First 16 EFPY (With Margins of 10°F and 60 psig for Instrumentation Errors and Margin of 74 psig for Pressure Difference Between Pressure Instrumentation and Reactor Vessel Beltline Region).



MATERIAL BASIS

Copper Content:	Assumed - NA WT% (Actual - 0.05 WT%)
RT_{NDT} Initial:	Assumed - NA °F (Actual - 50°F)
RT_{NDT} At 16 EFPY:	@ 1/4T = 112°F @ 3/4T = 94°F

Figure ~~3.4-3b~~ 2.1-2

Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown rates up to 100°F/hr) Applicable for the First 16 EFPY (With Margins of 10°F and 60 psig for Instrumentation Errors and Margin of 74 psig for Pressure Difference Between Pressure Instrumentation and Reactor Vessel Beltline Region).

~~VOGTLE UNITS 1 & 2~~ ~~3/4 4-32a~~

Amendment No. 87 (Unit 1)
Amendment No. 65 (Unit 2)

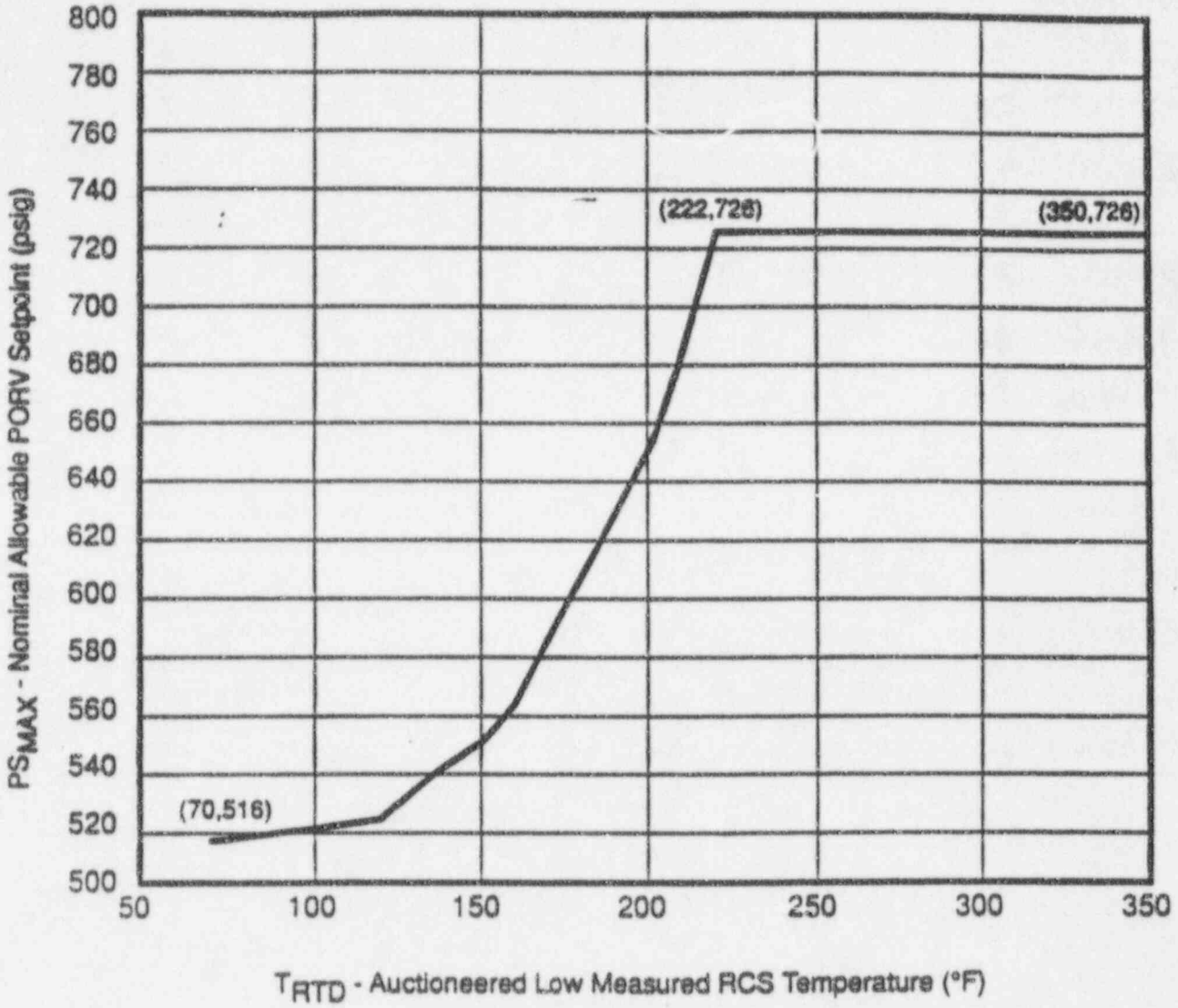


Figure ~~3.4-1b~~ 2.2-1
Unit 2 Maximum Allowable Nominal PORV Setpoint for
the Cold Overpressure Protection System

Amendment No. 87 (Unit 1)
Amendment No. 68 (Unit 2)

3.0 Supplemental Data Tables

Table 3.0-1 is a comparison of the measured surveillance material 30 ft-lb transition temperature shifts and upper shelf energy decreases with Regulatory Guide 1.99, Revision 2 predictions.

Table 3.0-2 shows the calculation of the surveillance material chemistry factors using surveillance capsule data. However, since there has been only one surveillance capsule removed from the Vogtle Unit 2 reactor vessel, this table has been intentionally left blank.

Table 3.0-3 provides the unirradiated Vogtle Unit 2 reactor vessel toughness data. The bolt-up temperature is also included in this table.

Table 3.0-4 provides a summary of the fluences used in the generation of the heatup and cooldown curves.

Table 3.0-5 provides a summary of the adjusted reference temperatures (ARTs) of the Vogtle Unit 2 reactor vessel beltline materials at the 1/4-T and 3/4-T locations for 16 EFPY.

Table 3.0-6 shows the calculation of the ART at 16 EFPY for the limiting Vogtle Unit 2 reactor vessel material lower shell plate B8628-1).

Table 3.0-7 provides a summary of the fluences used in the PTS evaluation.

Table 3.0-8 provides RT_{PTS} values for Vogtle Unit 2 for 32 EFPY.

Table 3.0-9 provides RT_{PTS} values for Vogtle Unit 2 for 48 EFPY.

Table 3.0-1

Comparison of the Vogtle Unit 2 Surveillance Material 30 ft-lb Transition Temperature Shifts and Upper Shelf Energy Decrease with Regulatory Guide 1.99 Revision 2 Predictions

Material	Capsule	Fluence ($\times 10^{19}$ n/cm^2, E > 1.0 MeV)	30 ft-lb Transition Temperature Shift		Upper Shelf Energy Decrease	
			Predicted[a] (°F)	Measured (°F)	Predicted[a] (%)	Measured (%)
Lower Shell Plate B8628-1 (Longitidinal)	U	0.444	24	0	16	0
Lower Shell Plate B8628-1 (Transverse)	U	0.444	24	0	16	0
Weld Metal	U	0.444	28	0	16	0
HAZ Metal	U	0.444	-	0	-	0

(a) Based on Regulatory Guide 1.99, Revision 2, methodology using mean wt. % values of Cu and Ni.

Table 3.0-2(*)						
Vogtle Unit 2 Calculation of Chemistry Factors Using Surveillance Capsule Data						
Material	Capsule	Fluence (f) (n/cm^2, $E > 1.0$ MeV)	FF(a)	ΔRT_{NDT} (°F)	$FF*\Delta RT_{NDT}$ (°F)	FF^2
				Sum:		
	Chemistry Factor =					
Weld Metal						
				Sum:		
	Chemistry Factor =					

(a) Fluence Factor (FF) per Regulatory Guide 1.99, Revision 2, is defined as $FF = f^{(0.28 - 0.10 \log f)}$

(*) This table was intentionally left blank since only one surveillance capsule has been removed from Vogtle Unit 2 to date.

Table 3.0-3			
Vogtle Unit 2 Reactor Vessel Toughness Table (Unirradiated)			
Material Description	Cu (%)[a]	Ni (%)[a]	Initial RT_{NDT} (°F)[b]
Closure Head Flange	--	--	10[c]
Vessel Flange	--	--	-60[c]
Intermediate Shell Plate R4-1	0.06	0.64	10
Intermediate Shell Plate R4-2	0.05	0.62	10
Intermediate Shell Plate R4-3	0.05	0.59	30
Lower Shell Plate B8825-1	0.05	0.59	40
Lower Shell Plate R8-1	0.06	0.62	40
Lower Shell Plate B8628-1	0.05	0.59	50
Longitudinal Welds	0.07	0.13	-10
Circumferential Weld	0.06	0.12	-30

(a) The average values of copper and nickel content.

(b) Initial RT_{NDT} values are measured values.

(c) These values are used for considering flange requirements for the heatup/cooldown curves. Per the methodology given in WCAP-14040, Revision 1, the minimum boltup temperature is 60 °F.

Table 3.0-4					
Vogtle Unit 2 Reactor Vessel Surface Fluence Values at 16 EFPY (Fluence Based on E > 1.0 MeV)					
Azimuthal	0°	15°	25°	35°	45°
Surface	8.99E+18	1.34E+19	1.52E+19	1.24E+19	1.42E+19

Table 2.0-5

Summary of Adjusted Reference Temperatures (ARTs) for the Vogtle Unit 2 Reactor Vessel Beltline Materials at the 1/4-T and 3/4-T Locations for 16 EFPY

Component	16 EFPY ART[a]	
	1/4-T (°F)	3/4-T (°F)
Intermediate Shell Plate R4-1	80	61
Intermediate Shell Plate R4-2	70	53
Intermediate Shell Plate R4-3	90	73
Lower Shell Plate B8825-1	100	83
Lower Shell Plate R8-1	110[b]	93[b]
Lower Shell Plate B8628-1	110[b]	93[b]
Longitudinal Welds	81	55
Circumferential Weld	54	29

(a) The ARTs presented here are based on the peak reactor vessel surface fluence of 1.52×10^{19} n/cm^2 (E > 1.0 MeV) at 16 EFPY, which is conservative for the longitudinal weld seams.

(b) These ART values are used to generate the heatup and cooldown curves.

Table 3.0-6		
Calculation of Adjusted Reference Temperature at 16 EFPY for the Limiting Vogtle Unit 2 Reactor Vessel Material (Lower Shell Plate B8628-1)		
Parameter	ART Value	
Operating Time	16 EFPY	
Material	B8628-1	B8628-1
Location	1/4-T	3/4-T
Chemistry Factor, CF (°F)	31	31
Fluence $\times 10^{19}$ n/cm^2 (E > 1.0 MeV), f[a]	0.9057	0.3215
Fluence Factor, FF[b]	0.972	0.688
$\Delta RT_{NDT} = CF \times FF$, (°F)	30	21.5
Initial RT_{NDT}, I (°F)	50	50
Margin, M (°F)[c]	30	21.5
ART = I + (CF x FF) + M (°F) per Regulatory Guide 1.99, Revision 2	110	93

(a) Fluence, f, is based upon f_{surf} (10^{19} n/cm^2, E > 1.0 MeV) = 1.52 at 16 EFPY. The Vogtle Unit 2 reactor vessel wall thickness is 8.625 inches at the beltline region.

(b) Fluence Factor (FF) per Regulatory Guide 1.99, Revision 2, is defined as $FF = f^{(0.28 - 0.10 \log f)}$.

(c) Margin is calculated as $M = 2(\sigma_i^2 + \sigma_\Delta^2)^{0.5}$. The standard deviation for the initial RT_{NDT} margin term, σ_i, is 0 °F since the initial RT_{NDT} is a measured value. The Standard deviation for ΔRT_{NDT} term σ_Δ, is 17 °F for the plate, except that σ_Δ need not exceed 0.5 times the mean value of ΔRT_{NDT}.

Table 3.0-7					
Neutron Exposure Projections[1] at Key Locations on the Vogtle Unit 2 Pressure Vessel Clad/Base Metal Interface					
EFPY	0°	15°	25°	35°	45°
32	1.80	2.69	3.04	2.47	2.84
48	2.70	4.05	4.56	3.69	4.26

(1) Fluence in 10^{19} n/cm^2 (E > 1.0 MeV).

Table 3.0-8

RT_{PTS} Values for Vogtle Unit 2 for 32 EFPY

Material	CF (°F)	Surface Fluence (n/cm², E > 1.0 MeV)	FF	ΔRT_{NDT} (C_1 x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Plate R4-1	37	3.04×10^{19}	1.29	47.7	10	34	92
Inter. Shell Plate R4-2	31	3.04×10^{19}	1.29	40.0	10	34	84
Inter. Shell Plate R4-3	31	3.04×10^{19}	1.29	40.0	30	34	104
Lower Shell Plate B8825-1	31	3.04×10^{19}	1.29	40.0	40	34	114
Lower Shell Plate R8-1	37	3.04×10^{19}	1.29	47.7	40	34	122
Lower Shell Plate B8628-1	31	3.04×10^{19}	1.29	40.0	50	34	124
Longitudinal Weld	47	3.04×10^{19}	1.29	60.6	-10	56	107
Circumferential Weld	43	3.04×10^{19}	1.29	55.5	-30	56	82

(1) RT_{PTS} values were calculated using the peak 32 EFPY vessel clad/base metal interface fluence of 3.04×10^{19} n/cm² (E > 1.0 MeV), which is conservative for the longitudinal weld seams (See Table 3.0-7).

Table 3.0-9

RT_{PTS} Values for Vogtle Unit 2 for 48 EFPY

Material	CF (°F)	Surface Fluence (n/cm², E > 1.0 MeV)	FF	ΔRT_{NDT} (CF x FF) (°F)	I (°F)	M (°F)	RT_{PTS} (°F)
Inter. Shell Plate R4-1	37	4.56×10^{19}	1.384	51.2	10	34	95
Inter. Shell Plate R4-2	31	4.56×10^{19}	1.384	42.9	10	34	87
Inter. Shell Plate R4-3	31	4.56×10^{19}	1.384	42.9	30	34	107
Lower Shell Plate B8825-1	31	4.56×10^{19}	1.384	42.9	40	34	117
Lower Shell Plate R8-1	37	4.56×10^{19}	1.384	51.2	40	34	125
Lower Shell Plate B8628-1	31	4.56×10^{19}	1.384	42.9	50	34	127
Longitudinal Weld	47	4.56×10^{19}	1.384	65.0	-10	56	11'
Circumferential Weld	43	4.56×10^{19}	1.384	59.5	-30	56	86

(1) RT_{PTS} values were calculated using the peak 48 EFPY vessel clad/base metal interface fluence of 4.56×10^{19} n/cm² (E > 1.0 MeV), which is conservative for the longitudinal weld seams (See Table 3.0-7).

4.0 Reactor Vessel Material Surveillance Program

The reactor vessel material surveillance program is in compliance with 10 CFR 50, Appendix H, and is described in section 16.3 of the VEGP FSAR.

5.0 References

1. WCAP-14040, Revision 1, December 1994, "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves."

2. Louis L. Wheeler to C. K. McCoy, dated June 8, 1995, "Issuance of Amendments - Vogtle Electric Generating Plant, Units 1 and 2 (TAC Nos. M90966 and M90967)."