VOGTLE ELECTRIC GENERATING PLANT - UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT

REVISION 0

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VOGTLE ELECTRIC GENERATING PLANT (VEGP) - UNIT 1

PRESSURE AND TEMPERATURE LIMITS REPORT

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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. The current limits were developed using a methodology that is in accordance with the NRC-approved methodology specified in Specification 5.6.6 (Ref. 1) with two exceptions. The two exceptions are the fluence methodology used to calculate the heatup and cooldown limits and the incorporation of random pressure uncertainty in the cold overpressure protection system setpoints. Future changes to these limits will be made in full compliance with the NRC-approved methodology, and the first revision to the limits after initial implementation of this PTLR will be submitted to the NRC for prior approval. Subsequent revisions will be made in accordance with the NRC-approved methodology without prior approval. It should be noted that the heatup and cooldown limit curves and the cold overpressure protection system setpoints were approved by the NRC staff by Amendment 87 dated June 8, 1995.

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.

The setpoints in combination with the relief capacity of the PORVs will protect the RCS from the limiting mass injection transient of two centrifugal charging pumps plus the positive displacement pump injecting into the RCS and the limiting heat input transient of starting a RCP with the RCS 50 ^{0}F colder than the secondary coolant.

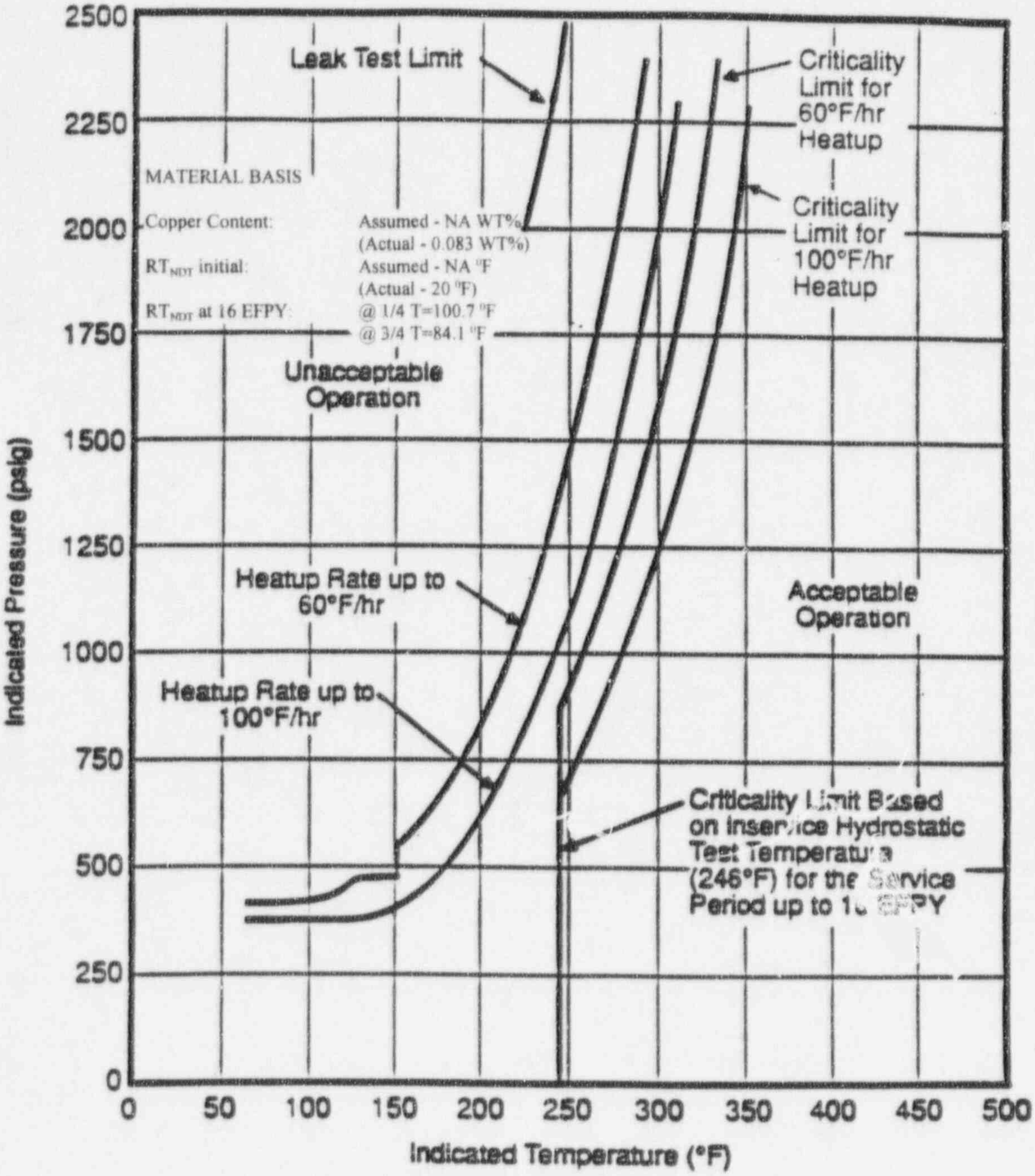

Figure 2.1-1

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).

Table 2.1-1
Data Points for Unit 1 Reactor Coolant System Heatup Limitations

60 HU		Criticality Limit		100 HU		Criticality Limit		Hydrostatic Leak Test	
T	P	T	P	T	P	T	P	T	P
70	411.59	246	0.00	70	379.59	246	0.00	225	2000
75	411.59	246	411.59	75	379.59	246	379.59	246	2485
80	411.59	246	411.59	80	379.59	246	379.59		
85	411.59	246	411.59	85	379.59	246	379.59		
90	411.59	246	411.59	90	379.59	246	379.59		
95	411.59	246	411.59	95	379.59	246	379.59		
100	413.02	246	413.02	100	379.59	246	379.59		
105	416.63	246	416.63	105	379.59	246	379.59		
110	422.40	246	422.40	110	379.59	246	379.59		
115	429.94	246	429.94	115	379.59	246	379.59		
120	439.34	246	439.34	120	381.23	246	381.23		
125	450.36	246	450.36	125	384.46	246	384.46		
130	462.96	246	462.96	130	389.32	246	389.32		
135	477.28	246	477.28	135	395.71	246	395.71		
140	487.00	246	487.00	140	403.67	246	403.67		
145	487.00	246	487.00	145	413.05	246	413.05		
150	487.00	246	487.00	150	424.12	246	424.12		
150	530.18	246	530.18	155	436.75	246	436.75		
155	551.31	246	551.31	160	451.02	246	451.02		
160	574.18	246	574.18	165	466.81	246	466.81		
165	599.11	246	599.11	170	484.47	246	484.47		
170	625.99	246	625.99	175	503.91	246	503.91		
175	654.97	246	654.97	180	525.12	246	525.12		
180	686.48	246	686.48	185	548.41	246	548.41		
185	720.23	246	720.23	190	573.65	246	573.65		
190	756.57	246	756.57	195	601.20	246	601.20		
195	795.85	246	795.85	200	630.96	246	630.96		
200	837.97	246	837.97	205	663.11	246	663.11		
205	883.21	246	883.21	210	698.05	250	698.05		
210	931.85	250	931.85	215	735.63	255	735.63		
215	984.06	255	984.06	220	776.14	260	776.14		
220	1039.90	260	1039.90	225	819.75	265	819.75		
225	1100.16	265	1100.16	230	866.71	270	866.71		
230	1164.70	270	1164.70	235	917.23	275	917.23		
235	1233.69	275	1233.69	240	971.48	280	971.48		
240	1308.02	280	1308.02	245	1029.79	285	1029.79		
245	1387.43	285	1387.43	250	1092.22	290	1092.22		
250	1472.31	290	1472.31	255	1159.47	295	1159.47		
255	1563.28	295	1563.28	260	1231.28	300	1231.28		
260	1660.77	300	1660.77	265	1308.60	305	1308.60		
265	1765.08	305	1765.08	270	1391.31	310	1391.31		
270	1876.53	310	1876.53	275	1479.80	315	1479.80		
275	1995.33	315	1995.33	280	1574.52	320	1574.52		
280	2122.41	320	2122.41	285	1675.74	325	1675.74		
285	2257.67	325	2257.67	290	1783.98	330	1783.98		
290	2401.70	330	2401.70	295	1899.51	335	1899.51		
				300	2023.06	340	2023.06		
				305	2154.59	345	2154.59		
				310	2294.65	350	2294.65		

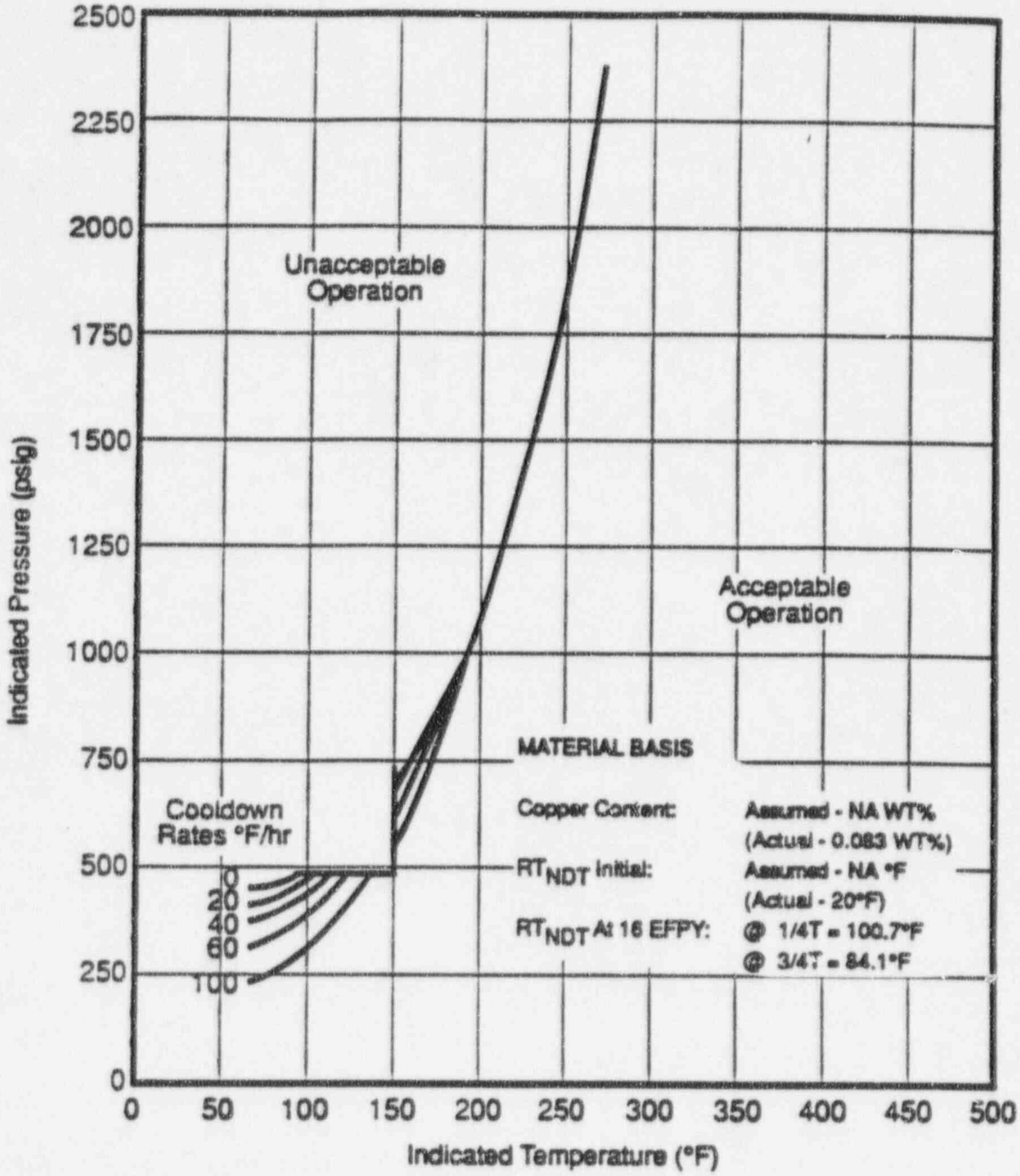

Figure 2.1-2

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).

Table 2.1-2
Data Points for Unit 1 Reactor Coolant System Cooldown Limitations

Steady State		20 CD		40 CD		60 CD		100 CD	
T	P	T	P	T	P	T	P	T	P
70	441.06	70	401.75	70	361.89	70	321.34	70	238.56
75	449.91	75	410.96	75	371.60	75	331.70	75	250.28
80	459.29	80	420.95	80	382.15	80	342.88	80	262.93
85	469.52	85	431.74	85	393.56	85	354.98	85	276.69
90	480.51	90	443.33	90	405.83	90	367.93	90	291.47
95	487.00	95	455.84	95	418.98	95	382.03	95	307.58
100	487.00	100	469.15	100	433.25	100	397.22	100	324.90
105	487.00	105	483.64	105	448.66	105	413.54	105	343.74
110	487.00	110	487.00	110	465.11	110	431.24	110	364.07
115	487.00	115	487.00	115	483.00	115	450.35	115	385.99
120	487.00	120	487.00	120	487.00	120	470.81	120	409.73
125	487.00	125	487.00	125	487.00	125	487.00	125	435.30
130	487.00	130	487.00	130	487.00	130	487.00	130	462.87
135	487.00	135	487.00	135	487.00	135	487.00	135	487.00
140	487.00	140	487.00	140	487.00	140	487.00	140	487.00
145	487.00	145	487.00	145	487.00	145	487.00	145	487.00
150	487.00	150	487.00	150	487.00	150	487.00	150	487.00
150	697.52	150	674.44	150	652.71	150	632.35	150	597.16
155	725.51	155	704.35	155	684.91	155	666.93	155	637.55
160	755.50	160	736.74	160	719.47	160	704.15	160	681.03
165	787.98	165	771.39	165	756.69	165	744.45	165	727.95
170	822.71	170	808.59	170	796.90	170	787.66	170	778.47
175	859.97	175	848.62	175	840.01	175	834.17	175	832.90
180	900.00	180	891.83	180	886.37	180	884.17	180	891.46
185	943.02	185	936.13	185	936.26	185	937.98		
190	989.43	190	987.88						
195	1038.93								
200	1092.31								
205	1149.67								
210	1211.10								
215	1276.80								
220	1347.74								
225	1423.41								
230	1504.91								
235	1591.99								
240	1685.30								
245	1785.26								
250	1892.15								
255	2006.55								
260	2128.76								
265	2259.41								
270	2398.54								

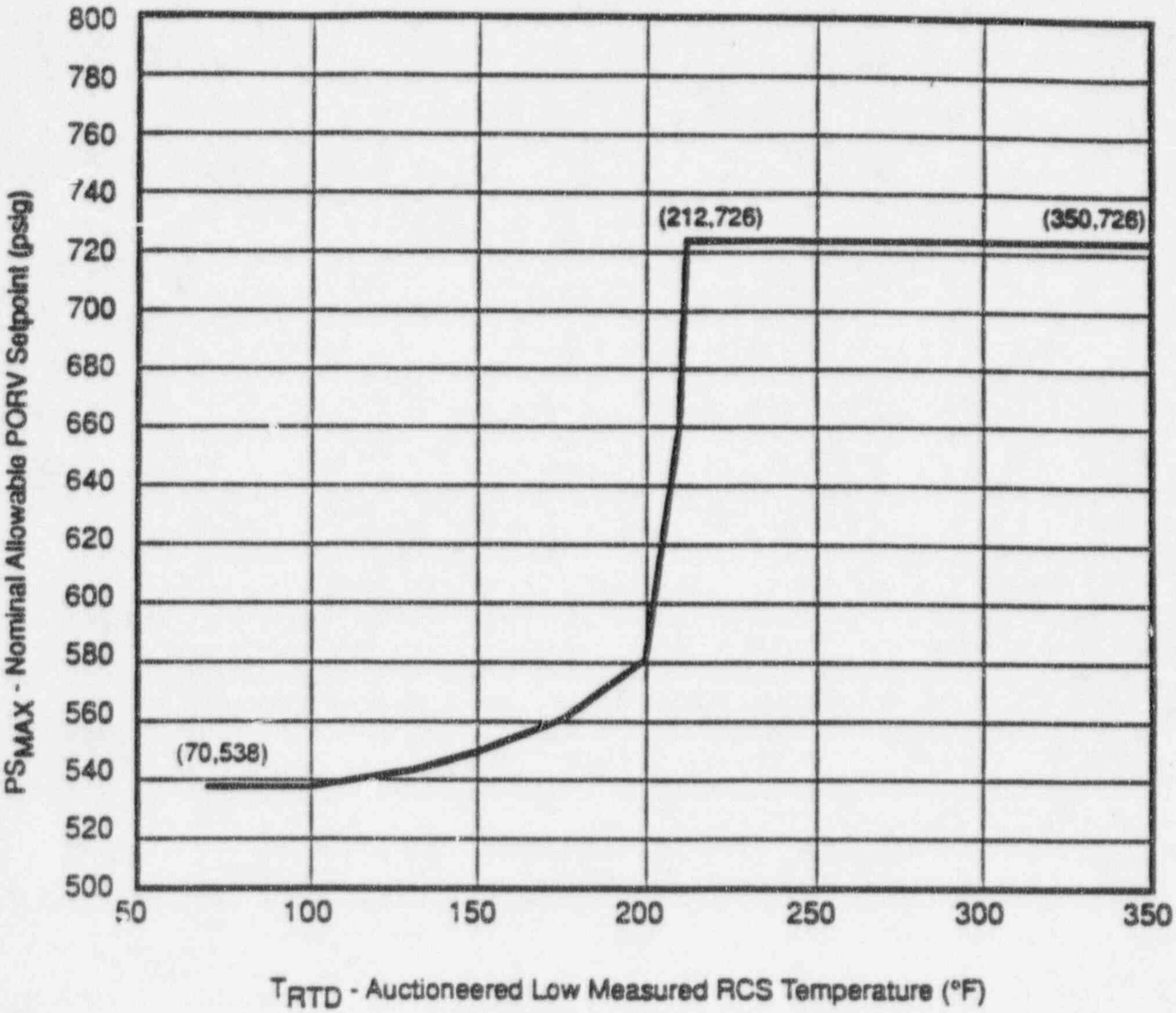

Figure 2.2-1
Unit 1 Maximum Allowable Nominal PORV Setpoint for the Cold Overpressure Protection System

Table 2.2-1
Data Points for Unit 1 PORV Setpoints

Temperature (^{0}F)	Pressure (psig)
70	538
100	538
130	540
160	550
180	560
200	576
210	660
212	726
350	726

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 ($x\ 10^{19}\ n/cm^2$, 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 (Longitudinal)	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} (^{O}F)	FF*ΔRT_{NDT} (^{O}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} (^{O}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 ^{O}F.

Table 3.0-4						
Vogtle Unit 1 Reactor Vessel Surface Fluence Values at 16 EFPY (Fluence Based on E > 1.0 MeV)						
Azimuthal	0^{O}	15^{O}	25^{O}	30^{O}	35^{O}	45^{O}
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 Vessel 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 (^{O}F)	53.1	53.1
Fluence ÷ 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, (^{O}F)	46.653	32.056
Initial RT_{NDT}, I (^{O}F)	20	20
Margin, M (^{O}F)[c]	34	32.056
ART = I + (CF x FF) + M (^{O}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 ^{O}F since the initial RT_{NDT} is a measured value. The Standard deviation for ΔRT_{NDT} term σ_Δ, is 17 ^{O}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 (^{o}F)	Surface Fluence (n/cm^2, E > 1.0 MeV)	FF	ΔRT_{NDT} (CF x FF) (^{o}F)	I (^{o}F)	M (^{o}F)	RT_{PTS} (^{o}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/cm^2, 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 (^oF)	Surface Fluence (n/cm^2, E > 1.0 MeV)	FF	ΔRT_{NDT} (CF x FF) (^oF)	I (^oF)	M (^oF)	RT_{PTS} (^oF)
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. The withdrawal schedule is presented in FSAR table 16.3-3. The Unit 1 surveillance capsule reports are as follows:

1. WCAP-12256, May 1989, "Analysis of Capsule U From the Georgia Power Company Vogtle Unit 1 Reactor Vessel Radiation Surveillance Program."
2. WCAP-13931, February 1994, "Analysis of Capsule Y From the Georgia Power Company Vogtle Unit 1 Reactor Vessel Radiation Surveillance Program."

5.0 Reactor Vessel Surveillance Data Credibility

Regulatory Guide 1.99, Revision 2, describes general procedures acceptable to the NRC staff for calculating the effects of neutron radiation embrittlement of the low-alloy steels currently used for light-water-cooled reactor vessels. Position C.2 of Regulatory Guide 1.99, Revision 2, describes the method for calculating the adjusted reference temperature and Charpy upper-shelf energy of reactor vessel beltline materials using surveillance capsule data. The methods of Position C.2 can only be applied when two or more credible surveillance data sets become available from the reactor in question.

To date, there have been two surveillance capsules removed from the Vogtle Unit 1 reactor vessel. To use these surveillance data sets, they must be shown to be credible. In accordance with the discussion of Regulatory Guide 1.99, Revision 2, there are five criteria that must be met for the surveillance data to be judged credible.

The purpose of this evaluation is to apply the credibility criteria of Regulatory Guide 1.99, Revision 2, to the Vogtle Unit 1 reactor vessel surveillance data and determine if the Vogtle Unit 1 surveillance data is credible.

Criterion 1: Materials in the capsules should be those judged most likely to be controlling with regard to radiation embrittlement.

The beltline region of the reactor vessel is defined in Appendix G to 10 CFR Part 50, "Fracture Toughness Requirements," May 27, 1983 to be:

"the reactor vessel (shell material including welds, heat affected zones, and plates or forgings) that directly surrounds the effective height of the active core and adjacent regions of the reactor vessel that are predicted to experience sufficient neutron radiation damage to be considered in the selection of the most limiting material with regard to radiation damage."

The Vogtle Unit 1 reactor vessel consists of the following beltline region materials:

a) Intermediate shell longitudinal weld seams 101-124A, B, and C, lower shell longitudinal seams 101-142A, B, and C, and intermediate to lower shell circumferential weld seam 101-171 (all beltline weld seams were fabricated with 3/16 inch Mil B-4 weld filler wire, heat number 83653 and Linde flux, lot number 3536),

b) Intermediate shell plates B8805-1, heat number C0613-1, B8805-2, heat number C0613-2, and B8805-3, heat number C0623-1, and

c) Lower shell plates B8606-1, heat number C2146-1, B8606-2, heat number C2146-2, and B8606-3, heat number C2085-2.

At the time the surveillance capsule was developed, Regulatory Guide 1.99, Revision 1 was in effect. Per the Regulatory Guide 1.99, Revision 1, calculational methodology, intermediate shell plate B8805-3 was projected to have the highest end of life (EOL) RT_{NDT} of all beltline plate materials. Hence, intermediate shell plate B8805-3 was judged to be most limiting and was used in the surveillance program. Since the surveillance weld metal and all of the Vogtle Unit 1 reactor vessel beltline welds were made of the same heat, flux, and flux lot, the surveillance weld represents the most limiting weld metal in the beltline region.

The materials selected for use in the Vogtle Unit 1 surveillance program were those judged to be most likely controlling with regard to radiation embrittlement according to the accepted methodology at the time the surveillance program was developed. Therefore, the Vogtle Unit 1 surveillance program meets this criteria.

Criterion 2: Scatter in the plots of Charpy energy versus temperature for the irradiated and unirradiated conditions should be small enough to permit the determination of the 30 ft-lb temperature and upper shelf energy unambiguously.

Plots of Charpy energy versus temperature for the unirradiated condition are presented in WCAP-11011, "Georgia Power Company Alvin W. Vogtle Unit No. 1 Reactor Vessel Radiation Surveillance Program," dated February 1986.

Plots of Charpy energy versus temperature for the irradiated condition are presented in WCAP-12256, "Analysis of Capsule U from the Georgia Power Company Vogtle Unit 1 Reactor Vessel Radiation Surveillance Program," dated May 1989 and WCAP-13931, Revision 1, "Analysis of Capsule Y from the Georgia Power Company Vogtle Unit 1 Reactor Vessel Radiation Surveillance Program," dated August 1995.

Based on engineering judgement, the scatter in the data presented in these plots is small enough to permit the determination of the 30-ft lb temperature and the upper shelf energy of the Vogtle Unit 1 surveillance materials unambiguously. Therefore, the Vogtle Unit 1 surveillance program meets this criteria.

Criterion 3: When there are two or more sets of surveillance data from one reactor, the scatter of ΔRT_{NDT} values about a best-fit line drawn as described in Regulatory Position 2.1 normally should be less than 28 ^{0}F for welds and 17 ^{0}F for base metal. Even if the fluence range is large (two or more orders of magnitude), the scatter should not exceed twice those values. Even if the data fail this criterion for use in shift calculations, they may be credible for determining decrease in upper shelf energy if the upper shelf can be clearly determined, following the definition given ASTM E185-82.

The least squares method as described in Regulatory Position 2.1 will be utilized to determine a best-fit line for this data and to determine if the scatter of these ΔRT_{NDT} values about this line is less than 28 ^{0}F for welds and 17 ^{0}F for the plate.

Table 5.0-1

Vogtle Unit 1 Surveillance Capsule Data
Calculation of Best Line Drawn as Described in Regulatory Position 2.1 of Regulatory Guide 1.99, Revision 2

Material	Capsule	$F^{(1)}$	$FF^{(2)}$ (x)	$\Delta RT_{NDT}^{(3)}$ (y)	$FF*\Delta RT_{NDT}$ (xy)	FF^2 (x^2)
Intermediate Shell Plate B8805-3 (Longitudinal)	U	0.3437	0.706	15	10.585	0.498
	Y	1.242	1.060	40	42.4	1.124
Intermediate Shell Plate B8805-3 (Transverse)	U	0.3437	0.706	0	0	0.498
	Y	1.242	1.060	20	21.2	1.124
	$\sum_{i=1}^{n}$		3.532	75	74.185	3.244
Weld Metal	U	0.3437	0.706	15	10.585	0.498
	Y	1.242	1.060	0	0	1.124
	$\sum_{i=1}^{n}$		1.766	15	10.585	1.622

(1) F = Fluence (10^{19} n/cm^2, E>1.0 MeV)
(2) FF = Fluence Factor = $F^{(0.28-0.1*\log F)}$
(3) ΔRT_{NDT} values do not include the adjustment ratio procedure of Regulatory Guide 1.99, Revision 2, Position 2.1, since the surveillance materials are identical to the actual beltline material.

Per the 27th Edition of the CRC Standard Mathematical Tables (page 497), for a straight line fit by the method of least squares, the values b_0 and b_1 are obtained by solving the normal equations

$$nb_0 + b_1\Sigma x_i = \Sigma y_i \qquad \text{and}$$

$$b_0\Sigma x_i + b_1\Sigma x_i^2 = \Sigma x_i y_i$$

These equations can be rewritten as follows:

$$\sum_{i=1}^{n} y_i = an + b\sum_{i=1}^{n} x_i \qquad \text{and}$$

$$\sum_{i=1}^{n} x_i y_i = a\sum_{i=1}^{n} x_i + b\sum_{i=1}^{n} x_i^2$$

Intermediate Shell Plate B8805-3:

Based on the data provided in Table 5.0-1, these equations become:

$$75 = 4a + 3.532b \qquad \text{and}$$

$$74.185 = 3.532a + 3.244b$$

Thus, b = 63.556 and a = -37.37, and the equation of the straight line which provides the best fit in the sense of least squares is:

$$Y' = 63.556\,(X) - 37.37$$

The error in predicting a value Y corresponding to a given X value is :

$$e = Y - Y'$$

Intermediate Shell Plate B8805-3 "Orientation"	FF	ΔRT_{NDT} (30 ft-lb) (°F)	Best Fit ΔRT_{NDT} (°F)	Scatter of ΔRT_{NDT} (°F)
Longitudinal	0.706	15	7.50	7.50
	1.060	40	30.0	10.0
Transverse	0.706	0	7.50	-7.50
	1.060	20	30.0	-10.0

The scatter of ΔRT_{NDT} values about a best-fit line drawn as described in Regulatory Position 2.1 is less than 17 °F as shown above. Therefore, this criteria is met for the surveillance plate material.

Weld Metal:

Based on the data provided in Table 5.0-1, the equations become:

$$15 = 2a + 1.766b \qquad \text{and}$$

$$10.585 = 1.766a + 1.622b$$

Thus a = 45.007 and b = -42.477, and the equation of the straight line which provides the best fit in the sense of least squares is:

$$Y' = -42.477\,(X) + 45.007$$

The error in predicting a value Y corresponding to a given X value is:

$$e = Y - Y'$$

FF	ΔRT_{NDT} (30 ft-lb) (°F)	Best Fit ΔRT_{NDT} (°F)	Scatter of ΔRT_{NDT} (°F)
0.706	15	15.0182	-0.0182
1.060	0	-0.0186	-0.0186

The scatter of ΔRT_{NDT} values about a best-fit line drawn as described in Regulatory Position 2.1 is less than 28 °F as shown above. Therefore, this criteria is met for the surveillance weld material.

Criterion 4: The irradiation temperature of the Charpy specimens in the capsule should match the vessel wall temperature at the cladding/base metal interface within +/- 35 °F.

The capsule specimens are located in the reactor between the core barrel and the vessel wall and are positioned opposite the center of the core. The test capsules are in baskets attached to the neutron pads. The location of the specimens with respect to the reactor vessel beltline provides assurance that the reactor vessel wall and the specimens experience equivalent operating conditions and will not differ by more than 25 °F.

Criterion 5: The surveillance data for the correlation monitor material in the capsule should fall within the scatter band of the data base for that material.

The Vogtle Unit 1 surveillance program does not include correlation monitor material. Therefore, this criterion is not applicable to Vogtle Unit 1.

6.0 References

1. WCAP-14040, Revision 1, December 1994, "Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves," as approved by the NRC by letter dated October 16, 1995 (TAC M91749).

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)."

Enclosure 2