Intracompany Correspondence

SOUTHERN COMPANY
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DATE: May 04, 2005

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RE: Vogtle Electric Generating Plant – Unit 1&2
Revision to the Pressure Temperature Limits Report (PTLR)

FROM: N. J. Stringfellow

TO: Pressure Temperature Limits Report (PTLR) Manual Holders

This package contains the following:

PTLR, Revision 2

This revision includes a revised PTLR that provides new heat up and cool down limits and COPS setpoints. In addition, this change relocates the COPS arming temperature to the PTLR and lowers the COPS arming temperature.

LDCR 2003088 and 2004013 were approved for this change.

NJS/TDH

Attachments: Instructions and Change Pages

cc: SNC Document Services - Rtype: CVA02.002

A001

Vogtle Electric Generating Plant Unit 1 and Unit 2

Pressure and Temperature Limits Report

Unit 1 and 2 Revision 1

May 4, 2005

Revision Insertion Instructions

Item	Instructions
Active PTLR List	Replace.
Title Page and Unit 1 Report	Replace.
Title Page and Unit 2 Report	Replace.

Vogtle Electric Generating Plant Unit 1 and Unit 2

Pressure and Temperature Limits Report List

May 4, 2005

Unit 1 Revision 1	April 2005
Unit 2 Revision 1	April 2005

Southern Nuclear Company

Vogtle Unit 1

Pressure Temperature Limits Report

Revision 2, April 2005

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1.0 RCS Pressure Temperature Limits Report (PTLR)

This PTLR for Vogtle 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)

Revisions to the PTLR shall be provided to the NRC after issuance.

2.0 RCS Pressure and Temperature (P/T) Limits

The limits for TS 3.4.3 are presented in the subsections which follow and were developed using the NRC approved methodology in WCAP-14040, Revision 4[1] with exception of WCAP-16142-P, Revision 1[2] (Elimination of the Flange Requirement). The operability requirements associated with COPS are specified in LCO 3.4.12 and were determined to adequately protect the RCS against brittle fracture in the event of a cold overpressure transient in accordance with the methodology specified in TS 5.6.6.

2.1 RCS P/T Limits (LCO 3.4.3)

2.1.1 The minimum boltup temperature is 60°F.

2.1.2 The RCS temperature rate-of-change limits are:

a. A maximum heatup rate of 100°F in any 1-hour period.

b. A maximum cooldown rate of 100°F in any 1-hour period.

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

2.1.3 The RCS P/T limits for heatup, cooldown, inservice hydrostatic and leak testing, and criticality are specified by Figures 2-1 and 2-2.

3.0 Cold Overpressure Protection Systems (LCO 3.4.12)

The setpoints for the pressurizer Power Operated Relief Valves (PORVs) and arming temperature are presented in the subsections which follow. These setpoints and arming temperature have been developed using the NRC-approved methodology specified in TS 5.6.6.

3.1 Pressurizer PORV Setpoints

The pressurizer PORV setpoints are specified in Figure 3-1 and Table 3-1. The limits for the COPS setpoints are contained in the 36 EFPY steady-state curves (Table 2-2), which are beltline conditions and are not compensated for pressure differences between the pressurizer transmitter and the reactor midplane/beltline or for instrument inaccuracies. The pressure difference between the pressurizer transmitter and the reactor vessel midplane/beltline with four reactor coolant pumps in operation is 74 psi.

Note: These setpoints include an allowance for the 50°F thermal transport effect for heat injection transients. A calculation has been performed to confirm that the setpoints will maintain the system pressure within the established limits when the pressure difference between the pressure transmitter and reactor midplane and maximum temperature/pressure instrument uncertainties are applied to the setpoints.

3.2 Arming Temperature

COPS shall be armed when any RCS cold leg temperature is ≤ 220° F.

4.0 Reactor Vessel Material Surveillance Program

The reactor vessel material irradiation surveillance specimens shall be removed and examined to determine changes in material properties. The removal schedule is provided in UFSAR Table 5.3.1-8. The results of these examinations shall be used to update Figures 2-1, 2-2, and 3-1.

The pressure vessel steel surveillance program (WCAP-11011[4]) is in compliance with Appendix H[3] to 10 CFR 50, "Reactor Vessel Material Surveillance Program Requirements." The material test requirements and the acceptance standard utilize the reference nil-ductility temperature RT_{NDT}, which is determined in accordance with ASTM E23[5]. The empirical relationship between RT_{NDT} and the fracture toughness of the reactor vessel steel is developed in accordance with Code Case N-640[6] of Section XI of the ASME Boiler and Pressure Vessel Code, Appendix G, "Fracture Toughness Criteria for Protection Against Failure"[7]. The surveillance capsule removal schedule meets the requirements of ASTM E185-82[8]. The removal schedule is provided in UFSAR Table 5.3.1-8.

5.0 Supplemental Data Tables

Table 5-1 contains a comparison of measured surveillance material 30 ft-lb transition temperature shifts and upper shelf energy decreases with Regulatory Guide 1.99, Revision 2[9], predictions.

Table 5-2 shows calculations of the surveillance material chemistry factors using surveillance capsule data. Note that in the calculation of the surveillance weld chemistry factor, the ratio procedure from Regulatory Guide 1.99, Revision 2 was followed. The ratio in question is equal to 1.02.

Table 5-3 provides the required Vogtle Unit 1 reactor vessel toughness data.

Table 5-4 provides a summary of the fluence values used in the generation of the heatup and cooldown limit curves and the PTS evaluation.

Table 5-5 and 5-6 show the calculation of the 1/4T and 3/4T adjusted reference temperature at 36 EFPY for each beltline material in the Vogtle Unit 1 reactor vessel. The limiting beltline material was the intermediate shell plate B8805-2.

Table 5-7 provides a summary of the adjusted reference temperature (ART) values of the Vogtle Unit 1 reactor vessel beltline materials at the 1/4T and 3/4T locations for 36 EFPY.

Table 5-8 provides RT_{PTS} values for Vogtle Unit 1 at 36 EFPY.

Table 5-9 provides RT_{PTS} values for Vogtle Unit 1 at 54 EFPY.

Material Property Basis

Limiting Material: Intermediate Shell Plate B8805-2
Limiting ART Values at 36 EFPY: 1/4T, 110°F
3/4T, 95°F

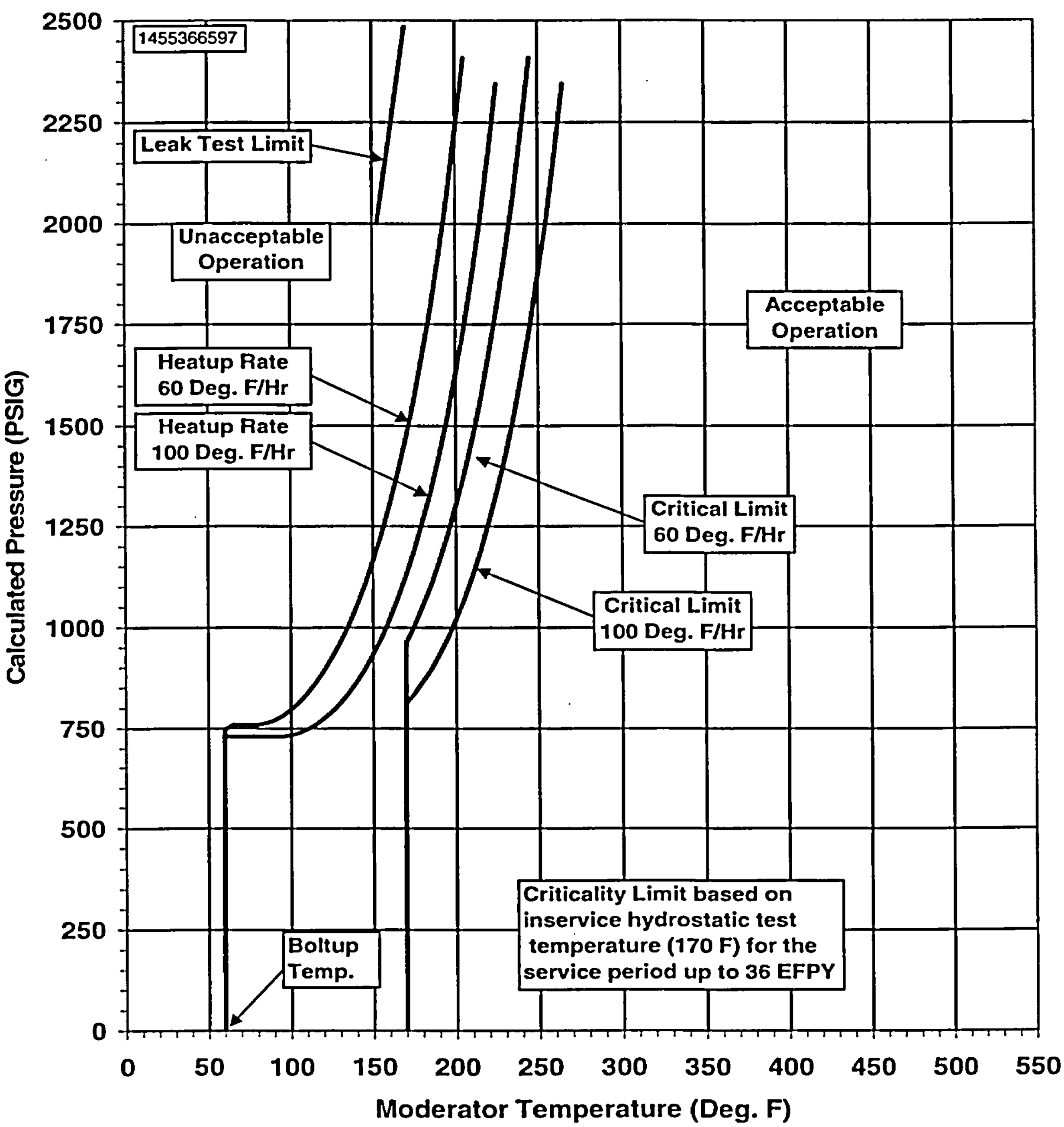

Figure 2-1 Vogtle Unit 1 Reactor Coolant System Heatup Limitations (Heatup Rate of 100°F/hr) Applicable for the First 36 EFPY (Without Margins for Instrumentation Errors) (*Plotted Data provided on Table 2-1)*

Material Property Basis

Limiting Material: Intermediate Shell Plate B8805-2
Limiting ART Values at 36 EFPY: 1/4T, 110°F
3/4T, 95°F

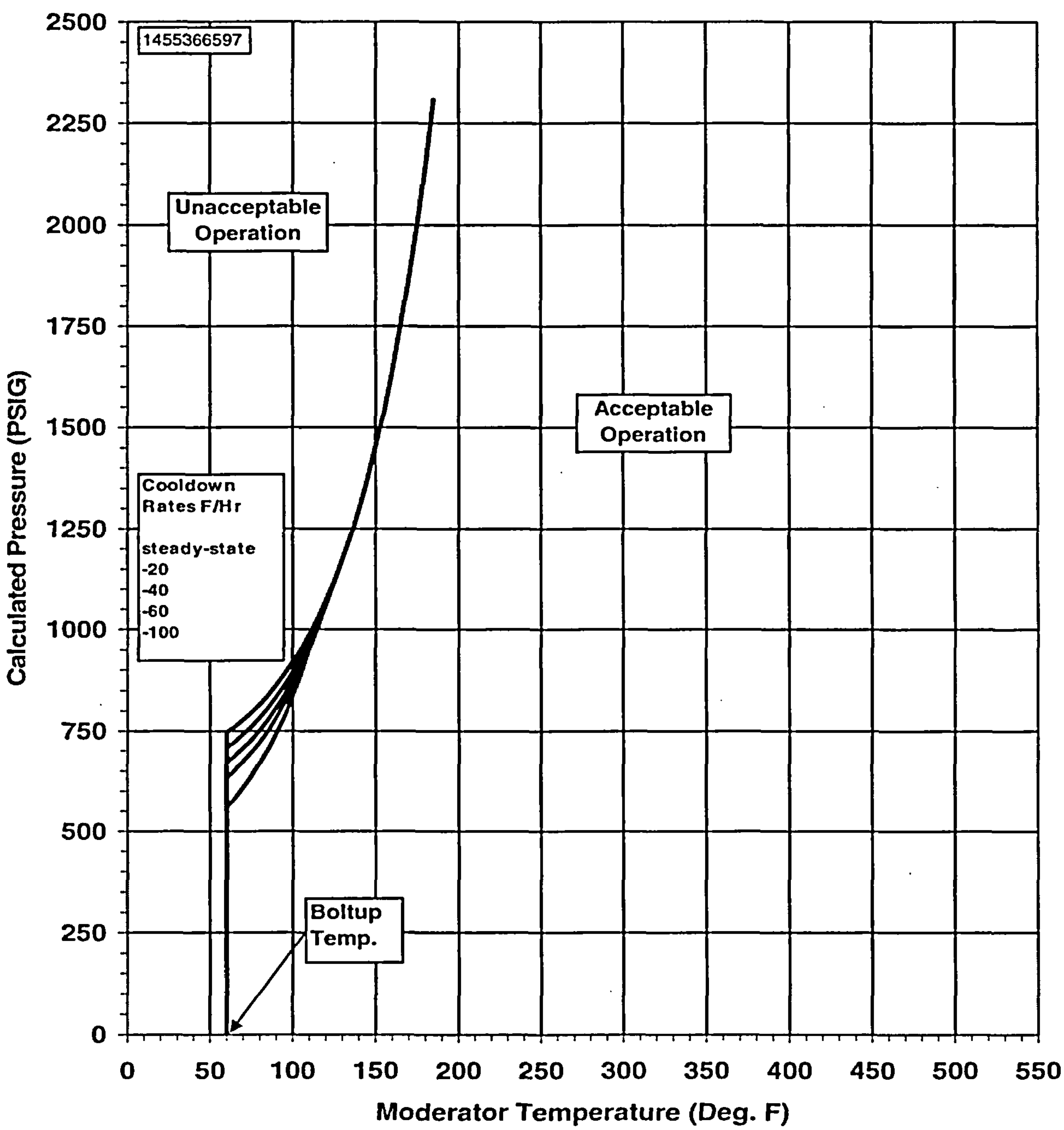

Figure 2-2 Vogtle Unit 1 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100°F/hr) Applicable for the First 36 EFPY (Without Margins for Instrumentation Error) ***(Plotted Data provided on Table 2-2)***

Table 2-1
Vogtle Unit 1 Heatup Limits at 36 EFPY
(Without Uncertainties for Instrumentation Errors)

60°F/hr Heatup		60°F/hr Heatup Criticality Limit		100°F/hr Heatup		100°F/hr Heatup Criticality Limit		Leak Test Limit	
T	P	T	P	T	P	T	P	T	P
60	0	170	0	60	0	170	0	153	2000
60	747	170	760	60	730	170	730	170	2485
65	760	170	760	65	730	170	730		
70	760	170	760	70	730	170	730		
75	760	170	760	75	730	170	730		
80	760	170	763	80	730	170	730		
85	763	170	770	85	730	170	730		
90	770	170	782	90	730	170	730		
95	782	170	796	95	730	170	733		
100	796	170	815	100	733	170	739		
105	815	170	836	105	739	170	747		
110	836	170	862	110	747	170	759		
115	862	170	891	115	759	170	774		
120	891	170	925	120	774	170	791		
125	925	170	962	125	791	170	812		
130	962	175	1005	130	812	175	837		
135	1005	180	1052	135	837	180	865		
140	1052	185	1105	140	865	185	897		
145	1105	190	1163	145	897	190	933		
150	1163	195	1228	150	933	195	974		
155	1228	200	1300	155	974	200	1020		
160	1300	205	1380	160	1020	205	1071		
165	1380	210	1468	165	1071	210	1128		
170	1468	215	1566	170	1128	215	1191		
175	1566	220	1674	175	1191	220	1261		
180	1674	225	1793	180	1261	225	1339		
185	1793	230	1925	185	1339	230	1426		
190	1925	235	2070	190	1426	235	1521		
195	2070	240	2231	195	1521	240	1627		
200	2231	245	2408	200	1627	245	1743		
205	2408			205	1743	250	1872		
				210	1872	255	2014		
				215	2014	260	2171		
				220	2171	265	2344		
				225	2344				

Table 2-2

Vogtle Unit 1 Cooldown Limits at 36 EFPY
(Without Uncertainties for Instrumentation Errors)

Steady State		20°F/hr		40°F/hr		60°F/hr		100°F/hr	
T	P	T	P	T	P	T	P	T	P
60	0	60	0	60	0	60	0	60	0
60	747	60	709	60	670	60	633	60	559
65	762	65	725	65	688	65	652	65	582
70	778	70	742	70	707	70	673	70	608
75	796	75	762	75	728	75	696	75	637
80	816	80	783	80	752	80	722	80	668
85	838	85	807	85	778	85	751	85	704
90	862	90	834	90	807	90	783	90	743
95	889	95	863	95	840	95	819	95	787
100	918	100	895	100	875	100	858	100	835
105	951	105	931	105	915	105	902	105	889
110	987	110	971	110	959	110	950	110	948
115	1027	115	1015	115	1007	115	1004		
120	1071	120	1063	120	1061				
125	1120	125	1117						
130	1173								
135	1233								
140	1299								
145	1371								
150	1452								
155	1541								
160	1639								
165	1747								
170	1867								
175	2000								
180	2146								
185	2308								

Table 3-1
Vogtle Unit 1 Data Points for the Maximum Allowable Nominal COPS PORV Setpoints

Temperature (Deg.F)	PORV Setpoint (psig)
70	612
90	612
140	642
201	760
202	760
350	760

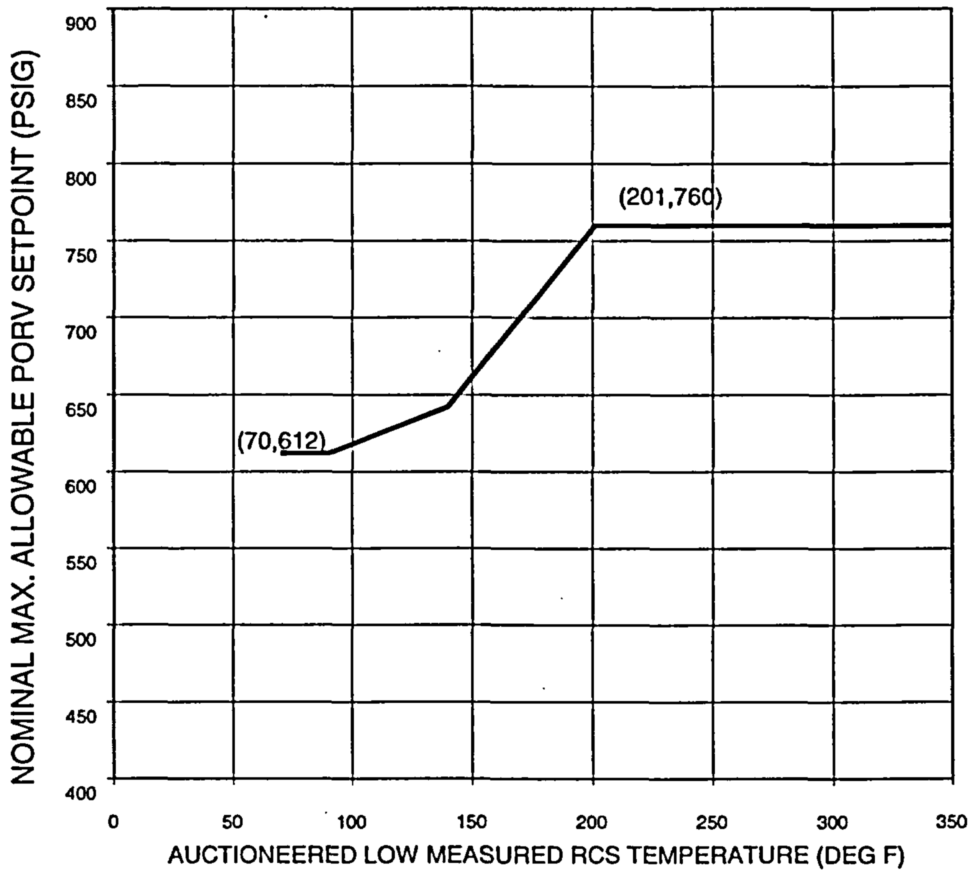

Figure 3-1: Vogtle Unit 1 Maximum Allowable Nominal PORV Setpoints for COPS

Table 5-1

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

Material	Capsule	Fluence[(d)] (x 10^{19} n/cm^2, E > 1.0 MeV)	30 ft-lb Transition Temperature Shift Predicted (°F) [(a)]	30 ft-lb Transition Temperature Shift Measured (°F) [(b)]	Upper Shelf Energy Decrease Predicted (%) [(a)]	Upper Shelf Energy Decrease Measured (%)[(c)]
Intermediate Shell Plate B8805-3[(h)] (Longitudinal)	U	0.334	26.80	13.56	14.5	0
	Y	1.16	39.97	31.94	19.5	0
	V	1.97	45.50	42.66	22	3
	X	3.53	51.03	96.50	26	11
Intermediate Shell Plate B8805-3[(h)] (Transverse)	U	0.334	26.80	0.00[(e)]	14.5	0
	Y	1.16	39.97	15.19	19.5	0
	V	1.97	45.50	33.79	22	2
	X	3.53	51.03	60.80	26	3
Surveillance Program Weld Metal[(i)]	U	0.334	23.52	24.98	14.5	0
	Y	1.16	35.08	7.70	19.5	0
	V	1.97	39.93	0.00[(f)]	22	2
	X	3.53	44.79	53.40	26	3
Heat Affected Zone Material	U	0.334	---	0.00[(g)]	---	5
	Y	1.16	---	20.78	---	9
	V	1.97	---	42.08	---	11
	X	3.53	---	10.60	---	7

Notes:

a. Based on Regulatory Guide 1.99, Revision 2, methodology using the mean weight percent values of copper and nickel of the surveillance material.
b. Calculated using measured Charpy data plotted using CVGRAPH, Version 5.0.2[11].
c. Values are based on the definition of upper shelf energy given in ASTM E185-82[8].
d. The fluence values presented here are the calculated values, not the best estimate values.
e. The actual value is -9.28. This physically should not occur, therefore 0.00 will be conservatively assumed.
f. The actual value is -1.34. This physically should not occur, therefore 0.00 will be conservatively assumed.
g. The actual value is -19.35. This physically should not occur, therefore 0.00 will be conservatively assumed.
h. The heat number for lower shell plate B8805-3 is C-0623-1.
i. The Surveillance weld was fabricated from Wire Heat No. 83653, Flux Type Linde 0091, Flux Lot No. 3536.

Table 5-2
Calculation of Chemistry Factors Using Vogtle Unit 1 Surveillance Capsule Data

Material	Capsule	Capsule f[a]	FF[b]	ΔRT_{NDT}[c]	FF*ΔRT_{NDT}	FF^2
Intermediate Shell Plate B8805-3[f] (Longitudinal)	U	0.334	0.698	13.56	9.5	0.487
	Y	1.16	1.041	31.94	33.3	1.084
	V	1.97	1.185	42.66	50.6	1.404
	X	3.53	1.329	96.50	128.2	1.766
Intermediate Shell Plate B8805-3[f] (Transverse)	U	0.334	0.698	0(e)	0.0	0.487
	Y	1.16	1.041	15.19	15.8	1.084
	V	1.97	1.185	33.79	40.0	1.404
	X	3.53	1.329	60.80	80.8	1.766
				SUM:	358.2	9.482
	$CF_{B8805-3} = \Sigma(FF * RT_{NDT}) \div \Sigma(FF^2) = (358.2) \div (9.482) = 37.8°F$					
Surveillance Weld Material[g]	U	0.334	0.698	25.48 (24.98)[d]	17.8	0.487
	Y	1.16	1.041	7.85 (7.70)[d]	8.2	1.084
	V	1.97	1.185	0[e]	0.0	1.404
	X	3.53	1.329	54.47 (53.40)[d]	72.4	1.766
				SUM:	98.4	4.741
	$CF_{Surv. Weld} = \Sigma(FF * RT_{NDT}) \div \Sigma(FF^2) = (98.4) \div (4.741) = 20.8°F$					

Notes:

a. f = Calculated fluence from capsule X dosimetry analysis results [12], (x 10^{19} n/cm^2, E > 1.0 MeV).
b. FF = fluence factor = $f^{(0.28 - 0.1*\log f)}$.
c. ΔRT_{NDT} values are the measured 30 ft-lb shift values taken from App. C of Ref. 12.
d. The surveillance weld metal ΔRT_{NDT} values have been adjusted by a ratio factor of 1.02.
e. Actual values for ΔRT_{NDT} are -9.28 (Plate) and -1.34 (Weld). This physically should not occur, therefore for conservatism a value of zero will be used for this calculation.
f. The heat number for lower shell plate B8805-3 is C-0623-1.
g. Surveillance Weld was fabricated from Wire Heat No.83653, Flux Type Linde 0091, Flux Lot No. 3536.

Table 5-3
Reactor Vessel Beltline Material Unirradiated Toughness Properties for Vogtle Unit 1

Material Description	Cu (%)	Ni(%)	Initial RT_{NDT}[a]
Closure Head Flange B8801-1 *(Heat # 123J173VA1)*	--	0.70	20°F
Vessel Flange B8802-1 *(Heat # 123H402VA1)*	--	0.71	0°F
Intermediate Shell Plate B8805-1 *(Heat # C-0613-1)*	0.083	0.597	0°F
Intermediate Shell Plate B8805-2 *(Heat # C-0613-2)*	0.083	0.61	20°F
Intermediate Shell Plate B8805-3 *(Heat # C-0623-1)*	0.062	0.598	30°F
Lower Shell Plate B8606-1 *(Heat # C-2146-1)*	0.053	0.593	20°F
Lower Shell Plate B8606-2 *(Heat # C-2146-2)*	0.057	0.60	20°F
Lower Shell Plate B8606-3 *(Heat # C-2085-2)*	0.067	0.623	10°F
Intermediate Shell Longitudinal Welds, 101-124A, B & C[b]	0.042	0.102	-80°F
Lower Shell Longitudinal Welds, 101-142A, B & C[b]	0.042	0.102	-80°F
Circumferential Weld 101-171[b]	0.042	0.102	-80°F
Surveillance Program Weld Metal[b]	0.040	0.102	--

Notes:

a. The initial RT_{NDT} values for the plates and welds are based on measured data.
b. All welds, including the surveillance weld, were fabricated with weld wire heat number 83653, Linde 0091 Flux, Lot No. 3536. Per Regulatory Guide 1.99, Revision 2, "weight percent copper" and "weight percent nickel" are the best-estimate values for the material, which will normally be the mean of the measured values for a plate or forging or for weld samples made with the weld wire heat number that matches the critical vessel weld.

Table 5-4
Peak Calculated Neutron Fluence Projections at Key Azimuthal Locations on the Reactor Vessel Clad/Base Metal Interface for Vogtle Unit 1 (n/cm^2, E > 1.0 MeV)

	Azimuthal Location			
EFPY	0°	15°	30°	45°
14.33[(a)]	4.35E+18	6.55E+18	8.11E+18	8.38E+18
20.00	6.13E+18	9.16E+18	1.12E+19	1.15E+19
24.00	7.38E+18	1.10E+19	1.33E+19	1.37E+19
32.00	9.89E+18	1.47E+19	1.77E+19	1.81E+19
40.00	1.24E+19	1.83E+19	2.20E+19	2.25E+19
48.00	1.49E+19	2.20E+19	2.63E+19	2.70E+19
54.00	1.68E+19	2.48E+19	2.95E+19	3.03E+19

(a) The end of cycle 11 (Actual) when Capsule X was withdrawn.

Table 5-5

Vogtle Unit 1 Calculation of the ART Values for the 1/4T Location @ 36 EFPY[a]

Material	RG 1.99 R2 Method	CF (°F)	FF	IRT_{NDT}[b]	ΔRT_{NDT}[c]	Margin[d]	ART[e]
Intermediate Shell Plate B8805-1	Position 1.1	53.1	1.06	0	56.3	34	90
Intermediate Shell Plate B8805-2	Position 1.1	53.1	1.06	20	56.3	34	**110**
Intermediate Shell Plate B8805-3	Position 1.1	38.4	1.06	30	40.7	34	105
	Position 2.1	24.4	1.06	30	26.0	17[f]	73
Lower Shell Plate B8606-1	Position 1.1	32.8	1.06	20	34.8	34	89
Lower Shell Plate B8606-2	Position 1.1	35.2	1.06	20	37.3	34	91
Lower Shell Plate B8606-3	Position 1.1	41.9	1.06	10	44.4	34	88
Inter. Shell Longitudinal Weld Seam 101-124A (*0° Azimuth*)	Position 1.1	34.5	0.899	-80	31.0	31	-18
	Position 2.1	8.6	0.899	-80	7.7	7.7[f]	-65
Inter. Shell Long. Weld Seams 101-124B,C (*120°, 240° Azimuth*)	Position 1.1	34.5	1.06	-80	36.6	36.6	-7
	Position 2.1	8.6	1.06	-80	9.1	9.1[f]	-62
Intermediate to Lower Shell Girth Weld Seam 101-171	Position 1.1	34.5	1.06	-80	36.6	36.6	-7
	Position 2.1	8.6	1.06	-80	9.1	9.1[f]	-62
Lower Shell Long. Weld Seams 101-142A,C (*60°, 300° Azimuth*)	Position 1.1	34.5	1.06	-80	36.6	36.6	-7
	Position 2.1	8.6	1.06	-80	9.1	9.1[f]	-62
Lower Shell Long. Weld Seam 101-142B (*180° Azimuth*)	Position 1.1	34.5	0.899	-80	31.0	31	-18
	Position 2.1	8.6	0.899	-80	7.7	7.7[f]	-65

Notes:

a. Calculation of ART values was based on calculated fluence projections and measured data from the previous capsule analysis results (Capsule V, Ref. 10). It should be noted that the fluence projections from Capsule V (Ref. 10) were higher than those from Capsule X (Ref. 12). However, the chemistry factors determined from surveillance data (Table 5-2) are now higher but still lower than the corresponding Position 1.1 chemistry factor. Therefore, the limiting ART values from Plate B8805-2 could not be exceeded by an updated plate B8805-3 ART value or updated weld ART values. Thus, the original limiting ART value is still valid. Note, the surveillance plate data is now deemed "Non-Credible," but this has no impact based on the preceding discussion.

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

c. $\Delta RT_{NDT} = CF * FF$

d. $M = 2 * (\sigma_i^2 + \sigma_\Delta^2)^{1/2}$

e. ART = Initial RT_{NDT} + ΔRT_{NDT} + Margin (°F); (Rounded per ASTM E29, using the "Rounding Method").

f. Weld data deemed credible per References 10 and 12. Plate data is now deemed "Non-Credible." See Note "a."

g. Neutron Fluence value used for all material is the highest value from Reference 10 for 36 EFPY with exception to intermediate shell longitudinal weld 101-124A and lower shell longitudinal weld 101-142B which used the fluence at 0° from Table 5-4 for 36 EFPY. It should be note that the fluence projections from Reference 10 are higher than the updated fluence analysis in Reference 12. See Note "a."

Table 5-6

Vogtle Unit 1 Calculation of the ART Values for the 3/4T Location @ 36 EFPY[a]

Material	RG 1.99 R2 Method	CF (°F)	FF	IRT_{NDT}[a]	ΔRT_{NDT}[b]	Margin[c]	ART[d]
Intermediate Shell Plate B8805-1	Position 1.1	53.1	0.773	0	41.0	34	75
Intermediate Shell Plate B8805-2	Position 1.1	53.1	0.773	20	41.0	34	95
Intermediate Shell Plate B8805-3	Position 1.1	38.4	0.773	30	29.7	29.7	89
	Position 2.1	24.4	0.773	30	18.9	17[f]	66
Lower Shell Plate B8606-1	Position 1.1	32.8	0.773	20	25.4	25.4	71
Lower Shell Plate B8606-2	Position 1.1	35.2	0.773	20	27.2	27.2	74
Lower Shell Plate B8606-3	Position 1.1	41.9	0.773	10	32.4	32.4	75
Inter. Shell Longitudinal Weld Seam 101-124A (*0° Azimuth*)	Position 1.1	34.5	0.622	-80	21.5	21.5	-37
	Position 2.1	8.6	0.622	-80	5.3	5.3[f]	-69
Inter. Shell Long. Weld Seams 101-124B,C (*120°, 240° Azimuth*)	Position 1.1	34.5	0.773	-80	26.7	26.7	-27
	Position 2.1	8.6	0.773	-80	6.6	6.6[f]	-67
Intermediate to Lower Shell Girth Weld Seam 101-171	Position 1.1	34.5	0.773	-80	26.7	26.7	-27
	Position 2.1	8.6	0.773	-80	6.6	6.6[f]	-67
Lower Shell Long. Weld Seams 101-142A,C (*60°, 300° Azimuth*)	Position 1.1	34.5	0.773	-80	26.7	26.7	-27
	Position 2.1	8.6	0.773	-80	6.6	6.6[f]	-67
Lower Shell Long. Weld Seam 101-142B (*180° Azimuth*)	Position 1.1	34.5	0.622	-80	21.5	21.5	-37
	Position 2.1	8.6	0.622	-80	5.3	5.3[f]	-69

Notes:

a. Calculation of ART values was based on calculated fluence projections and measured data from the previous capsule analysis results (Capsule V, Ref. 10). It should be noted that the fluence projections from Capsule V (Ref. 10) were higher than those from Capsule X (Ref. 12). However, the chemistry factors determined from surveillance data (Table 5-2) are now higher but still lower than the corresponding Position 1.1 chemistry factor. Therefore, the limiting ART values from Plate B8805-2 could not be exceeded by an updated plate B8805-3 ART value or updated weld ART values. Thus, the original limiting ART value is still valid. Note, the surveillance plate data is now deemed "Non-Credible," but this has no impact based on the preceding discussion.
b. Initial RT_{NDT} values are measured values.
c. $\Delta RT_{NDT} = CF * FF$
d. $M = 2 *(\sigma_i^2 + \sigma_\Delta^2)^{1/2}$
e. ART = Initial RT_{NDT} + ΔRT_{NDT} + Margin (°F); (Rounded per ASTM E29, using the "Rounding Method").
f. Weld data deemed credible per References 10 and 12. Plate data is now deemed "Non-Credible." See Note "a."
g. Neutron Fluence value used for all material is the highest value from Reference 10 for 36 EFPY with exception to intermediate shell longitudinal weld 101-124A and lower shell longitudinal weld 101-142B which used the fluence at 0° from Table 5-4 for 36 EFPY. It should be note that the fluence projections from Reference 10 are higher than the updated fluence analysis in Reference 12. See Note "a."

Table 5-7
Summary of the Vogtle Unit 1 Reactor Vessel Beltline Material ART Values

Material	RG 1.99 R2 Method	1/4 ART (°F)	3/4 ART (°F)
Intermediate Shell Plate B8805-1	Position 1.1	90	75
Intermediate Shell Plate B8805-2	Position 1.1	110	95
Intermediate Shell Plate B8805-3	Position 1.1	105	89
	Position 2.1	73	66
Lower Shell Plate B8606-1	Position 1.1	89	71
Lower Shell Plate B8606-2	Position 1.1	91	74
Lower Shell Plate B8606-3	Position 1.1	88	75
Inter. Shell Longitudinal Weld	Position 1.1	-18	-37
Seam 101-124A (0° Azimuth)	Position 2.1	-65	-69
Inter. Shell Long. Weld Seams	Position 1.1	-7	-27
101-124B,C (120°, 240° Azimuth)	Position 2.1	-62	-67
Intermediate to Lower Shell	Position 1.1	-7	-27
Girth Weld Seam 101-171	Position 2.1	-62	-67
Lower Shell Long. Weld Seams	Position 1.1	-7	-27
101-142A,C (60°, 300° Azimuth)	Position 2.1	-62	-67
Lower Shell Long. Weld Seam	Position 1.1	-18	-37
101-142B (180° Azimuth)	Position 2.1	-65	-69

Table 5-8

RT_{PTS} Calculations for Vogtle Unit 1 Beltline Region Materials at 36 EFPY[f]

Material	RG 1.99 R2 Method	CF (°F)	FF	$IRT_{NDT(U)}$[a]	ΔRT_{PTS}[b]	Margin[c]	RT_{PTS}[d]
Intermediate Shell Plate B8805-1	Position 1.1	53.1	1.19	0	63.2	34	97
Intermediate Shell Plate B8805-2	Position 1.1	53.1	1.19	20	63.2	34	117
Intermediate Shell Plate B8805-3	Position 1.1	38.4	1.19	30	45.7	34	110
	Position 2.1	37.8	1.19	30	45.0	34[e]	109
Lower Shell Plate B8606-1	Position 1.1	32.8	1.19	20	39.0	34	93
Lower Shell Plate B8606-2	Position 1.1	35.2	1.19	20	41.9	34	96
Lower Shell Plate B8606-3	Position 1.1	41.9	1.19	10	49.9	34	94
Inter. Shell Long. Weld Seams	Position 1.1	34.5	1.19	-80	41.1	41.1	2
101-124A, B, C (0°, 120°, 240° Azimuth)	Position 2.1	20.8	1.19	-80	24.8	24.8	-30
Intermediate to Lower Shell Girth Weld Seam 101-171	Position 1.1	34.5	1.19	-80	41.1	41.1	2
	Position 2.1	20.8	1.19	-80	24.8	24.8	-30
Lower Shell Long. Weld Seams	Position 1.1	34.5	1.19	-80	41.1	41.1	2
101-142A, B, C (60°, 300° Azimuth)	Position 2.1	20.8	1.19	-80	24.8	24.8	-30

Notes:

a. Initial RT_{NDT} values are measured values.
b. $\Delta RT_{PTS} = CF * FF$
c. $M = 2 * (\sigma_i^2 + \sigma_\Delta^2)^{1/2}$
d. RTPTS = $RT_{NDT(U)} + \Delta RT_{PTS}$ + Margin (°F)
e. Data deemed "Non-Credible" per Reference 12.
f. Neutron Fluence value used for all material is the highest value from Table 5-4 for 36 EFPY.

Table 5-9

RT_{PTS} Calculations for Vogtle Unit 1 Beltline Region Materials at 54 EFPY[f]

Material	RG 1.99 R2 Method	CF (°F)	FF	$IRT_{NDT(U)}$[a]	ΔRT_{PTS}[b]	Margin[c]	RT_{PTS}[d]
Intermediate Shell Plate B8805-1	Position 1.1	53.1	1.29	0	34	34	103
Intermediate Shell Plate B8805-2	Position 1.1	53.1	1.29	20	34	34	123
Intermediate Shell Plate B8805-3	Position 1.1	38.4	1.29	30	34	34	114
	Position 2.1	37.8	1.29	30	34	34[e]	113
Lower Shell Plate B8606-1	Position 1.1	32.8	1.29	20	34	34	96
Lower Shell Plate B8606-2	Position 1.1	35.2	1.29	20	34	34	99
Lower Shell Plate B8606-3	Position 1.1	41.9	1.29	10	34	34	98
Inter. Shell Longitudinal Weld Seams 101-124A,B,C (0°120°, 240° Azimuth)	Position 1.1	34.5	1.29	-80	44.5	44.5	9
	Position 2.1	20.8	1.29	-80	26.8	26.8	-26
Intermediate to Lower Shell Girth Weld Seam 101-171	Position 1.1	34.5	1.29	-80	44.5	44.5	9
	Position 2.1	20.8	1.29	-80	26.8	26.8	-26
Lower Shell Long. Weld Seams 101-142A, B, C (60°, 300° Azimuth)	Position 1.1	34.5	1.29	-80	44.5	44.5	9
	Position 2.1	20.8	1.29	-80	26.8	26.8	-26

Notes:

a. Initial RT_{NDT} values are measured values.
b. $\Delta RT_{PTS} = CF * FF$
c. $M = 2 *(\sigma_I^2 + \sigma_\Delta^2)^{1/2}$
d. $RT_{PTS} = RT_{NDT(U)} + \Delta RT_{PTS} + \text{Margin}$ (°F)
e. Data deemed "Non-Credible" per Reference 12.
f. Neutron Fluence value used for all material is the highest value from Table 5-4 for 54 EFPY.

6.0 References

1. WCAP-14040-NP-A, Revision 4, "Methodology used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves," J.D. Andrachek, et. al.

2. WCAP-16142-P, Revision 1, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation for Vogtle Units 1 and 2," Warren Bamford, et. al., February 2004.

3. Code of Federal Regulations, 10CFR50, Appendix H, *Reactor Vessel Material Surveillance Program Requirements*, U.S. Nuclear Regulatory Commission, Washington, D.C.

4. WCAP-11011, *Georgia Power Company Alvin W. Vogtle Unit No. 2 Reactor Vessel Radiation Surveillance Program*, L. R. Singer, February 1986.

5. ASTM E23 *Standard Test Method Notched Bar Impact Testing of Metallic Materials*, in ASTM Standards, American Society for Testing and Materials, Philadelphia, PA.

6. ASME Code Case N-640, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves for Section XI, Division 1," February 26, 1999.

7. Section XI of the ASME Boiler and Pressure Vessel Code, Appendix G, *Fracture Toughness Criteria for Protection Against Failure.*

8. ASTM E185-82, Annual Book of ASTM Standards, Section 12, Volume 12.02, *Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels.*

9. Regulatory Guide 1.99, Revision 2, *Radiation Embrittlement of Reactor Vessel Materials*, U.S. Nuclear Regulatory Commission, May 1988.

10. WCAP-15067, *Analysis of Capsule V From the Southern Nuclear Vogtle Electric Generating Plant Unit 1 Reactor Vessel Radiation Surveillance Program*, T.J. Laubham, et. al., dated September 1998. [*Note that the Testing/Analysis reports for surveillance capsules U and Y from Vogtle Unit 1 were documented under WCAP-12256 and WCAP-13931, Rev. 1, respectively.*]

11. CVGRAPH, Hyperbolic Tangent Curve-Fitting Program, Version 5.0.2, developed by ATI Consulting, February 2003.

12. WCAP-16278, *Analysis of Capsule X From the Southern Nuclear Operating Company Vogtle Unit 1 Reactor Vessel Radiation Surveillance Program*, K.G. Knight, et. al., dated July 2004.

Southern Nuclear Company

Vogtle Unit 2

Pressure Temperature Limits Report

Revision 2, April 2005

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List of Tables

List of Figures

1.0 RCS Pressure Temperature Limits Report (PTLR)

This PTLR for Vogtle 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)

Revisions to the PTLR shall be provided to the NRC after issuance.

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

The limits for TS 3.4.3 are presented in the subsections which follow and were developed using the NRC approved methodology in WCAP-14040, Revision 4[1] with exception of WCAP-16142-P, Revision 1[2] (elimination of the flange requirement). The operability requirements associated with the COPS are specified in LCO 3.4.12 and were determined to adequately protect the RCS against brittle fracture in the event of a cold overpressure transient in accordance with the methodology specified in TS 5.6.6.

2.1 RCS P/T Limits (LCO 3.4.3)

2.1.1 The minimum boltup temperature is 60°F.

2.1.2 The RCS temperature rate-of-change limits are:

a. A maximum heatup rate of 100°F in any 1-hour period.

b. A maximum cooldown rate of 100°F in any 1-hour period.

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

2.1.3 The RCS P/T limits for heatup, cooldown, inservice hydrostatic and leak testing, and criticality are specified by Figures 2-1 and 2-2.

3.0 Cold Overpressure Protection Systems (LCO 3.4.12)

The setpoints for the pressurizer Power Operated Relief Valves (PORVs) and arming temperature are presented in the subsections which follow. These setpoints and arming temperature have been developed using the NRC-approved methodology specified in TS 5.6.6.

3.1 Pressurizer PORV Setpoints

The pressurizer PORV setpoints are specified in Figure 3-1 and Table 3-1. The limits for the COPS setpoints are contained in the 36 EFPY steady-state curves (Table 2-2), which are beltline conditions and are not compensated for pressure differences between the pressurizer transmitter and the reactor midplane/beltline or for instrument inaccuracies. The pressure difference between the pressurizer transmitter and the reactor vessel midplane/beltline with four reactor coolant pumps in operation is 74 psi.

Note: These setpoints include an allowance for the 50°F thermal transport effect for heat injection transients. A calculation has been performed to confirm that the setpoints will maintain the system pressure within the established limits when the pressure difference between the pressure transmitter and reactor midplane and maximum temperature/pressure instrument uncertainties are applied to the setpoints.

3.2 Arming Temperature

COPS shall be armed when any RCS cold leg temperature is ≤ 220° F.

4.0 Reactor Vessel Material Surveillance Program

The reactor vessel material irradiation surveillance specimens shall be removed and examined to determine changes in material properties. The removal schedule is provided in UFSAR Table 5.3.1-9. The results of these examinations shall be used to update Figures 2-1, 2-2, and 3-1.

The pressure vessel steel surveillance program (WCAP-11381[4]) is in compliance with Appendix H[3] to 10 CFR 50, "Reactor Vessel Material Surveillance Program Requirements." The material test requirements and the acceptance standard utilize the reference nil-ductility temperature RT_{NDT}, which is determined in accordance with ASTM E23[5]. The empirical relationship between RT_{NDT} and the fracture toughness of the reactor vessel steel is developed in accordance with Code Case N-640[6] of Section XI of the ASME Boiler and Pressure Vessel Code, Appendix G, "Fracture Toughness Criteria for Protection Against Failure"[7]. The surveillance capsule removal schedule meets the requirements of ASTM E185-82[8]. The removal schedule is provided in UFSAR Table 5.3.1-9.

5.0 Supplemental Data Tables

Table 5-1 contains a comparison of measured surveillance material 30 ft-lb transition temperature shifts and upper shelf energy decreases with Regulatory Guide 1.99, Revision 2[9], predictions.

Table 5-2 shows calculations of the surveillance material chemistry factors using surveillance capsule data. Note that in the calculation of the surveillance weld chemistry factor, the ratio procedure from Regulatory Guide 1.99, Revision 2 was followed. The ratio in question is equal to 1.19.

Table 5-3 provides the required Vogtle Unit 2 reactor vessel toughness data.

Table 5-4 provides a summary of the fluence values used in the generation of the heatup and cooldown limit curves and the PTS evaluation.

Table 5-5 and 5-6 show the calculation of the 1/4T and 3/4T adjusted reference temperature at 36 EFPY for each beltline material in the Vogtle Unit 2 reactor vessel. The limiting beltline material was the lower shell plate R8-1.

Table 5-7 provides a summary of the adjusted reference temperature (ART) values of the Vogtle Unit 2 reactor vessel beltline materials at the 1/4T and 3/4T locations for 36 EFPY.

Table 5-8 provides RT_{PTS} values for Vogtle Unit 2 at 36 EFPY.

Table 5-9 provides RT_{PTS} values for Vogtle Unit 2 at 54 EFPY.

MATERIAL PROPERTY BASIS

Limiting Material: Lower Shell Plate R8-1

Limiting ART Values at 36 EFPY: 1/4T, 120°F
3/4T, 107°F

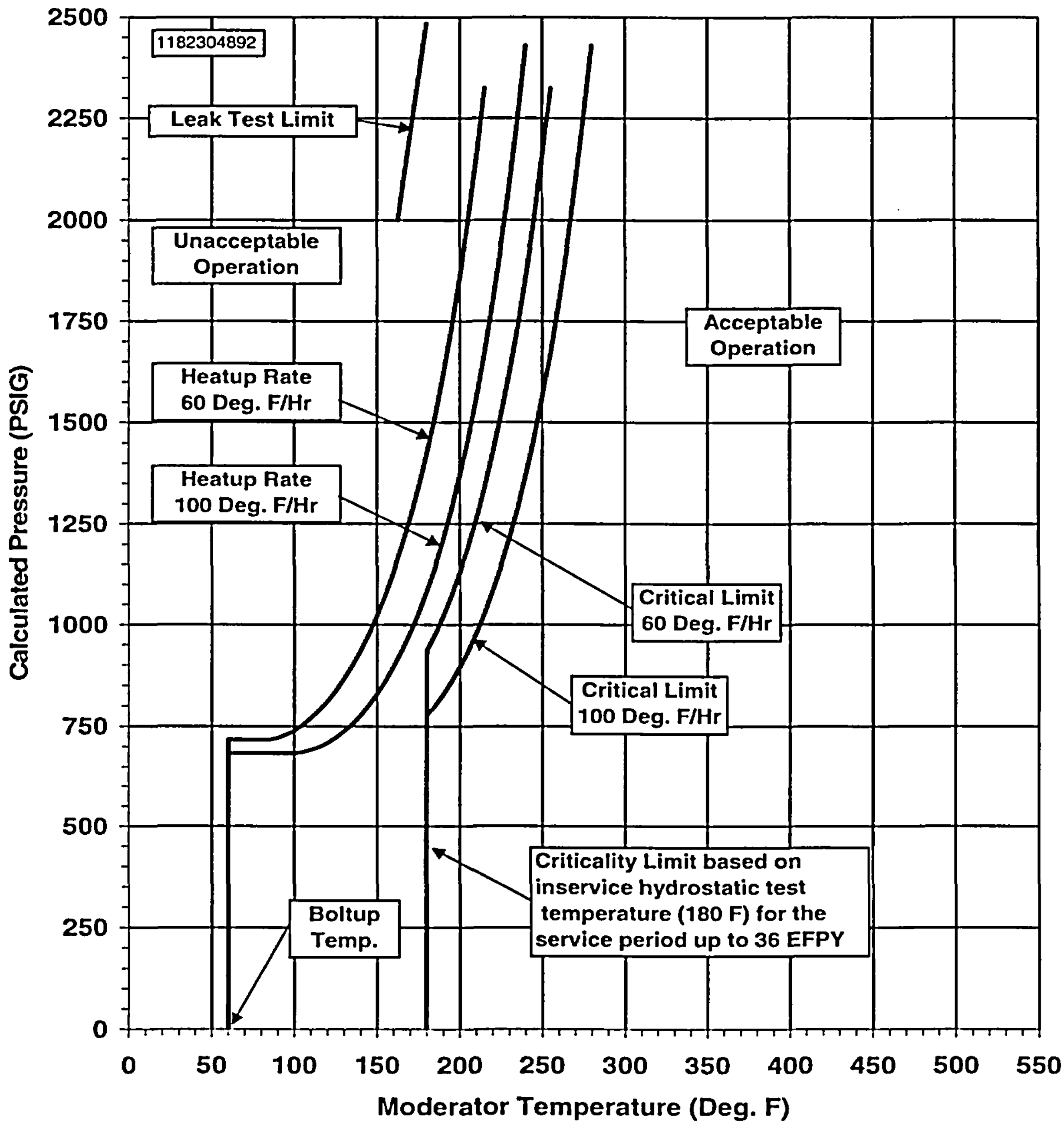

Figure 2-1 Vogtle Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rate of 100°F/hr) Applicable for the First 36 EFPY (Without Margins for Instrumentation Errors) *(Plotted Data provided on Table 2-1)*

MATERIAL PROPERTY BASIS

Limiting Material: Lower Shell Plate R8-1
Limiting ART Values at 36 EFPY: 1/4T, 120°F
3/4T, 107°F

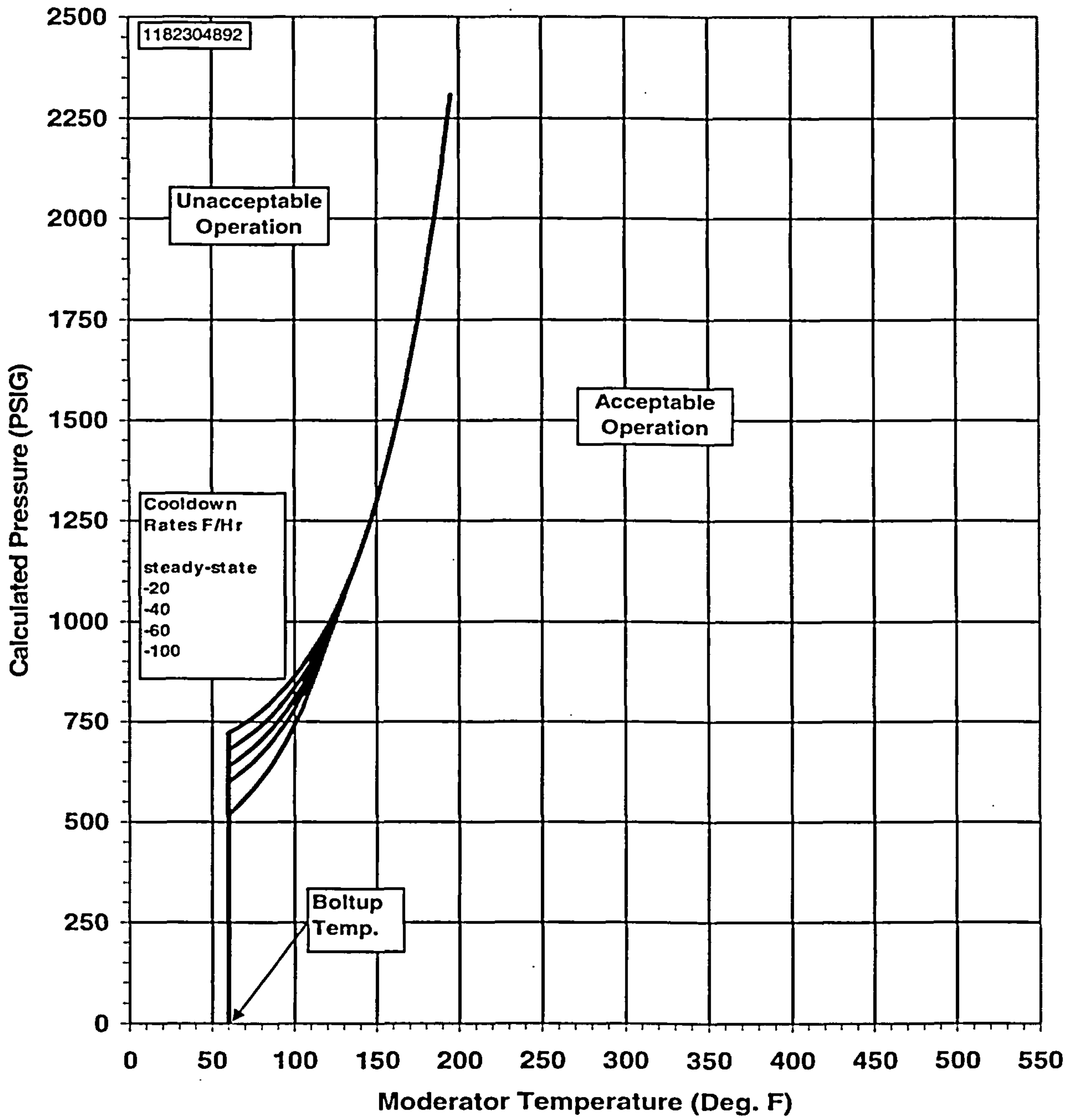

Figure 2-2 Vogtle Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100°F/hr) Applicable for the First 36 EFPY (Without Margins for Instrumentation Error) *(Plotted Data provided on Table 2-2)*

Table 2-1
Vogtle Unit 2 Heatup Limits at 36 EFPY
(Without Uncertainties for Instrumentation Errors)

60°F/hr Heatup		60°F/hr Heatup Criticality Limit		100°F/hr Heatup		100°F/hr Heatup Criticality Limit		Leak Test Limit	
T	P	T	P	T	P	T	P	T	P
60	0	180	0	60	0	180	0	163	2000
60	717	180	734	60	684	180	684	180	2485
65	717	180	727	65	684	180	684		
70	717	180	720	70	684	180	684		
75	717	180	717	75	684	180	684		
80	717	180	717	80	684	180	684		
85	717	180	721	85	684	180	684		
90	721	180	729	90	684	180	684		
95	729	180	739	95	684	180	684		
100	739	180	753	100	684	180	686		
105	753	180	769	105	686	180	691		
110	769	180	788	110	691	180	699		
115	788	180	811	115	699	180	709		
120	811	180	837	120	709	180	722		
125	837	180	866	125	722	180	737		
130	866	180	899	130	737	180	756		
135	899	180	936	135	756	180	777		
140	936	185	977	140	777	185	801		
145	977	190	1023	145	801	190	829		
150	1023	195	1074	150	829	195	860		
155	1074	200	1130	155	860	200	896		
160	1130	205	1193	160	896	205	935		
165	1193	210	1262	165	935	210	979		
170	1262	215	1339	170	979	215	1029		
175	1339	220	1424	175	1029	220	1084		
180	1424	225	1517	180	1084	225	1144		
185	1517	230	1621	185	1144	230	1212		
190	1621	235	1735	190	1212	235	1287		
195	1735	240	1861	195	1287	240	1369		
200	1861	245	2000	200	1369	245	1461		
205	2000	250	2154	205	1461	250	1562		
210	2154	255	2324	210	1562	255	1673		
215	2324			215	1673	260	1796		
				220	1796	265	1932		
				225	1932	270	2082		
				230	2082	275	2248		
				235	2248	280	2430		
				240	2430				

Table 2-2

Vogtle Unit 2 Cooldown Limits at 36 EFPY
(Without Uncertainties for Instrumentation Errors)

Steady State		20°F/hr		40°F/hr		60°F/hr		100°F/hr	
T	P	T	P	T	P	T	P	T	P
60	0	60	0	60	0	60	0	60	0
60	722	60	681	60	640	60	599	60	518
65	734	65	694	65	654	65	614	65	537
70	747	70	708	70	670	70	632	70	557
75	762	75	724	75	687	75	651	75	581
80	778	80	742	80	706	80	672	80	606
85	796	85	761	85	728	85	695	85	635
90	816	90	783	90	752	90	721	90	667
95	838	95	807	95	778	95	750	95	703
100	862	100	833	100	807	100	782	100	742
105	889	105	863	105	839	105	818	105	786
110	918	110	895	110	875	110	858	110	834
115	951	115	931	115	914	115	901	115	888
120	987	120	971	120	958	120	950	120	948
125	1027	125	1015	125	1007	125	1003		
130	1071	130	1063	130	1060				
135	1120	135	1117						
140	1173								
145	1233								
150	1299								
155	1371								
160	1452								
165	1541								
170	1639								
175	1747								
180	1867								
185	2000								
190	2146								
195	2308								

Table 3-1
Vogtle Unit 2 Data Points for the Maximum Allowable Nominal COPS PORV Setpoints

Temperature (Deg.F)	PORV Setpoint (psig)
70	580
90	580
140	612
201	760
202	760
350	760

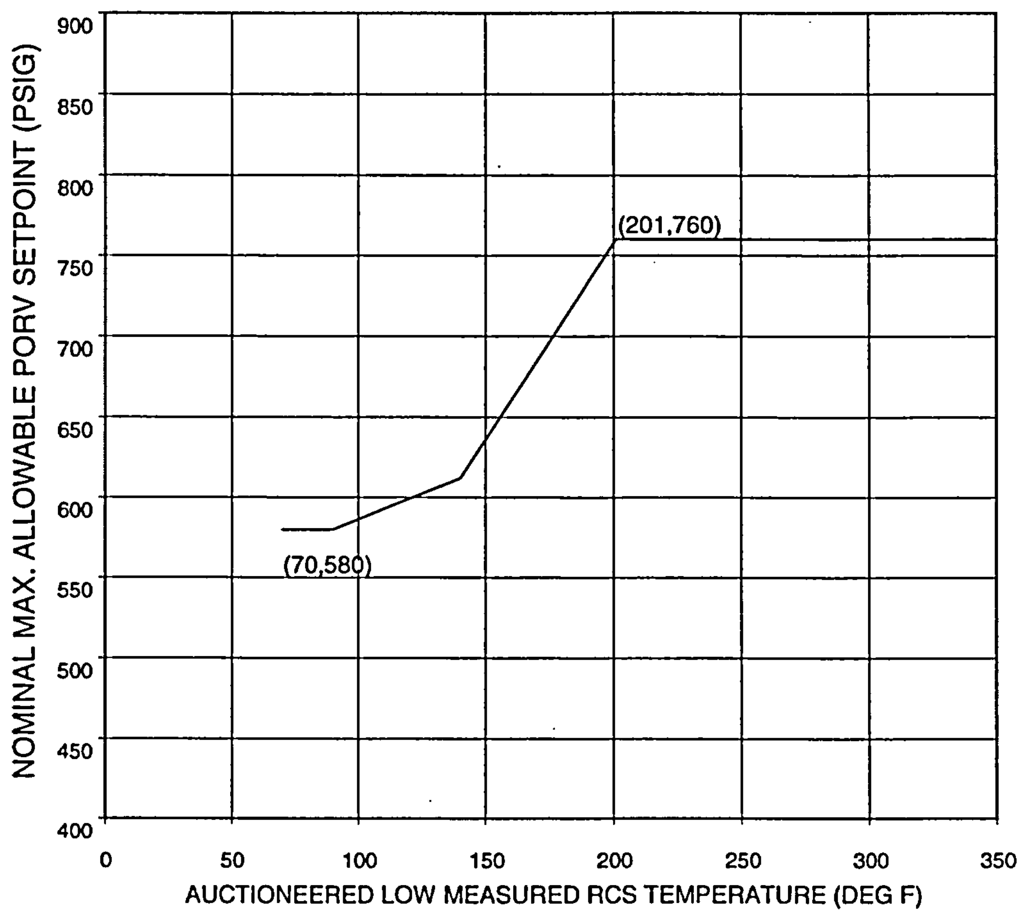

Figure 3-1: Vogtle Unit 2 Maximum Allowable Nominal PORV Setpoints for COPS

Table 5-1

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

			30 ft-lb Transition Temperature Shift		Upper Shelf Energy Decrease	
Material	**Capsule**	**Fluence ($x\ 10^{19}\ n/cm^2$)**	**Predicted (°F) (a)**	**Measured (°F) (b)**	**Predicted (%) (a)**	**Measured (%)(c)**
Lower Shell Plate B8628-1(e) (*Longitudinal*)	U	0.356	22.2	2.0	15	0
	Y	1.12	31.9	5.8	19.5	0
	X	1.78	36.0	29.4	22	3
	W	2.98	40.0	39.0	25	6
Lower Shell Plate B8628-1(e) (*Transverse*)	U	0.356	22.2	0.0(d)	15	0
	Y	1.12	31.9	1.9	19.5	0
	X	1.78	36.0	29.8	22	7
	W	2.98	40.0	45.5	25	1
Weld Metal(f)	U	0.356	26.0	0.00(d)	15	0
	Y	1.12	37.5	18.7	19.5	7
	X	1.78	42.2	19.9	22	7
	W	2.98	47.0	31.4	25	5
HAZ Metal	U	0.356	---	0.00(d)	---	0
	Y	1.12	---	0.00(d)	---	0
	X	1.78	---	0.00(d)	---	7
	W	2.98	---	3.2	---	6

Notes:

a. Based on Regulatory Guide 1.99, Revision 2, methodology using the mean weight percent values of copper and nickel of the surveillance material.
b. Calculated using measured Charpy data plotted using CVGRAPH, Version 5.0.2[11].
c. Values are based on the definition of upper shelf energy given in ASTM E185-82[8].
d. Actual values for ΔRT_{NDT} are -7.1 (Plate), -17.3 (Weld), -24.3 (HAZ Cap. U), -10.1(HAZ Cap. Y) and -2.5 (HAZ Cap. X). This physically should not occur, therefore for conservatism a value of zero will be reported (i.e.,No Change in T_{30}).
e. The heat number for lower shell plate B8628-1 is C-3500-2.
f. The Surveillance weld was fabricated from Wire Heat No. 87005, Flux Type Linde 124, Flux Lot No. 1061.

Table 5-2

Calculation of Chemistry Factors using Vogtle Unit 2 Surveillance Capsule Data

Material	Capsule	Capsule f[a]	FF[b]	ΔRT_{NDT}[c]	FF*ΔRT_{NDT}	FF^2
Lower Shell[f] Plate B8628-1 (*Longitudinal*)	U	0.356	0.715	2.0	1.43	0.511
	Y	1.12	1.03	5.8	5.97	1.06
	X	1.78	1.16	29.4	34.10	1.35
	W	2.98	1.29	39.0	50.31	1.66
Lower Shell[f] Plate B8628-1 (*Transverse*)	U	0.356	0.715	0.0[e]	0.00	0.511
	Y	1.12	1.03	1.9	1.96	1.06
	X	1.78	1.16	29.8	34.57	1.35
	W	2.98	1.29	45.5	58.70	1.66
				SUM:	187.04	9.162
	$CF_{B8628-1} = \Sigma(FF * RT_{NDT}) \div \Sigma(FF^2) = (187.04) \div (9.162) = 20.4°F$					
Surveillance Weld Material[g] (*Heat # 87005*)	U	0.356	0.715	0.0[e]	0.00	0.511
	Y	1.12	1.03	22.25(*18.7*)[d]	22.92	1.06
	X	1.78	1.16	23.68(*19.9*)[d]	27.47	1.35
	W	2.98	1.29	37.37(*31.4*)[d]	48.21	1.66
				SUM:	98.60	4.581
	$CF_{Surv. Weld} = \Sigma(FF * RT_{NDT}) \div \Sigma(FF^2) = (98.60) \div (4.581) = 21.5°F$					

Notes:

a. f = Calculated fluence from capsule W dosimetry analysis results[12], (x 10^{19} n/cm^2, E > 1.0 MeV).

b. FF = fluence factor = $f^{(0.28 - 0.1 * \log f)}$.

c. ΔRT_{NDT} values are the measured 30 ft-lb shift values taken from App. C of Ref. 12.

d. The surveillance weld metal ΔRT_{NDT} values have been adjusted by a ratio factor of 1.19.

e. Actual values for ΔRT_{NDT} are -7.1 (Plate) and -17.3 (Weld). This physically should not occur; therefore for conservatism a value of zero will be used.

f. The heat number for lower shell plate B8628-1 is C-3500-2.

g. Surveillance Weld was fabricated from Wire Heat No. 87005, Flux Type Linde 124, Flux Lot No. 1061.

Table 5-3
Reactor Vessel Beltline Material Unirradiated Toughness Properties for Vogtle Unit 2

Material Description	Cu (%)	Ni(%)	Initial RT_{NDT}[(a)]
Closure Head Flange R7-1 (*Heat # 125L630VA1*)	---	0.72	10°F
Vessel Flange R1-1	---	0.87	-60°F
Intermediate Shell Plate R4-1 (*Heat # C-3527-1*)	0.07	0.63	10°F
Intermediate Shell Plate R4-2 (*Heat # C-3527-2*)	0.06	0.61	10°F
Intermediate Shell Plate R4-3 (*Heat # C-3552-1*)	0.05	0.60	30°F
Lower Shell Plate B8825-1 (*Heat # C-3500-1*)	0.06	0.62	40°F
Lower Shell Plate R8-1 (*Heat # C-4304-1*)	0.07	0.63	40°F
Lower Shell Plate B8628-1 (*Heat # C-3500-2*)	0.05	0.59	50°F
Intermediate Shell Longitudinal Weld Seams 101-124A, B & C	0.05	0.15	-10°F
Lower Shell Longitudinal Weld Seams 101-142A, B & C	0.05	0.15	-10°F
Intermediate to Lower Shell Plate Circumferential Weld Seam 101-171	0.05	0.15	-30°F
Surveillance Weld[(b)]	0.04	0.13	---

Notes:

a. The initial RT_{NDT} values for the plates and welds are based on measured data.

b. The weld material in the Vogtle Unit 2 surveillance program was made of the same wire and flux as the reactor vessel intermediate to lower shell girth seam weld (101-171). These welds were fabricated using weld wire heat no. 87005, Linde 124 Flux, lot no. 1061. The intermediate shell longitudinal weld seams (101-124A,B,C) and the lower shell longitudinal weld seams (101-142A,B,C) were fabricated using weld wire heat no. 87005, Linde 0091 Flux, lot no. 0145. Hence the surveillance weld is representative of all beltline welds.

Table 5-4
Peak Calculated Neutron Fluence Projections at Key Azimuthal Locations on the Reactor Vessel Clad/Base Metal Interface for Vogtle Unit 2 (n/cm^2, E > 1.0 MeV)

	Azimuthal Location			
EFPY	**0°**	**15°**	**30°**	**45°**
13.29(a)	4.01E+18	5.91E+18	7.02E+18	7.20E+18
14.59	4.42E+18	6.52E+18	7.70E+18	7.87E+18
32.00	9.87E+18	1.46E+19	1.69E+19	1.70E+19
40.00	1.24E+19	1.84E+19	2.12E+19	2.11E+19
48.00	1.49E+19	2.21E+19	2.54E+19	2.53E+19
54.00	1.68E+19	2.49E+19	2.86E+19	2.85E+19

(a) The end of cycle 10 (Actual) when Capsule "W" was withdrawn.

Table 5-5
Vogtle Unit 2 Calculation of the ART Values for the 1/4T Location @ 36 EFPY[a]

Material	RG 1.99 R2 Method	CF (°F)	FF	IRT_{NDT}[b]	ΔRT_{NDT}[c]	Margin[d]	ART[e]
Intermediate Shell Plate R4-1	Position 1.1	44.0	1.051	10	46.2	34	90
Intermediate Shell Plate R4-2	Position 1.1	37.0	1.051	10	38.9	34	83
Intermediate Shell Plate R4-3	Position 1.1	31.0	1.051	30	32.6	32.6	95
Lower Shell Plate B8825-1	Position 1.1	37.0	1.051	40	38.9	34	113
Lower Shell Plate R8-1	Position 1.1	44.0	1.051	40	46.2	34	120
Lower Shell Plate B8628-1	Position 1.1	31.0	1.051	50	32.6	32.6	115
	Position 2.1	12.9[a]	1.051	50	13.6	13.6[f]	77
Intermediate Shell Longitudinal Weld Seams 101-124A, B, C	Position 1.1	43.3	1.051	-10	45.5	45.5	81
	Position 2.1	16.7[a]	1.051	-10	17.6	17.6[f]	25
Lower Shell Longitudinal Weld Seams 101-142A, B, C	Position 1.1	43.3	1.051	-10	45.5	45.5	81
	Position 2.1	16.7[a]	1.051	-10	17.6	17.6[f]	25
Intermediate to Lower Shell Circ. Weld Seam 101-171	Position 1.1	43.3	1.051	-30	45.5	45.5	61
	Position 2.1	16.7[a]	1.051	-30	17.6	17.6[f]	5

Notes:

a. Calculation of ART values was based on calculated fluence projections and measured data from the previous capsule analysis results (Capsule X, Ref. 10). It should be noted that the fluence projections from Capsule X (Ref. 10) were higher than those from Capsule W (Ref. 12). However, the chemistry factors determined from surveillance data (Table 5-2) are now higher, but still lower than the corresponding Position 1.1 chemistry factor. Therefore, the limiting ART values from Plate R8-1 could not be exceeded by an updated plate B8628-1 ART value or updated weld ART values. Thus, the original limiting ART value is still valid.

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

c. $\Delta RT_{NDT} = CF * FF$

d. $M = 2 * (\sigma_i^2 + \sigma_\Delta^2)^{1/2}$

e. ART = Initial RT_{NDT} + ΔRT_{NDT} + Margin (°F); (Rounded per ASTM E29, using the "Rounding Method").

f. Data deemed credible per Reference 10 and 12.

g. Neutron Fluence value used for all material is the highest value from Reference 10 for 36 EFPY. It should be noted that the fluence projections from Reference 10 are higher than the updated fluence analysis in Reference 12. See Note "a."

Table 5-6
Vogtle Unit 2 Calculation of the ART Values for the 3/4T Location @ 36 EFPY[f]

Material	RG 1.99 R2 Method	CF (°F)	FF	IRT_{NDT}[a]	ΔRT_{NDT}[b]	Margin[c]	ART[d]
Intermediate Shell Plate R4-1	Position 1.1	44.0	0.763	10	33.6	33.6	77
Intermediate Shell Plate R4-2	Position 1.1	37.0	0.763	10	28.2	28.2	66
Intermediate Shell Plate R4-3	Position 1.1	31.0	0.763	30	23.7	23.7	77
Lower Shell Plate B8825-1	Position 1.1	37.0	0.763	40	28.2	28.2	96
Lower Shell Plate R8-1	Position 1.1	44.0	0.763	40	33.6	33.6	**107**
Lower Shell Plate B8628-1	Position 1.1	31.0	0.763	50	23.7	23.7	97
	Position 2.1	12.9	0.763	50	9.8	9.8[e]	70
Intermediate Shell Longitudinal Weld Seams 101-124A, B, C	Position 1.1	43.3	0.763	-10	33.0	33.0	56
	Position 2.1	16.7	0.763	-10	12.7	12.7[e]	15
Lower Shell Longitudinal Weld Seams 101-142A, B, C	Position 1.1	43.3	0.763	-10	33.0	33.0	56
	Position 2.1	16.7	0.763	-10	12.7	12.7[e]	15
Intermediate to Lower Shell Circ. Weld Seam 101-171	Position 1.1	43.3	0.763	-30	33.0	33.0	36
	Position 2.1	16.7	0.763	-30	12.7	12.7[e]	-5

Notes:

a. Calculation of ART values was based on calculated fluence projections and measured data from the previous capsule analysis results (Capsule X, Ref. 10). It should be noted that the fluence projections from Capsule X (Ref. 10) were higher than those from Capsule W (Ref. 12). However, the chemistry factors determined from surveillance data (Table 5-2) are now higher, but still lower than the corresponding Position 1.1 chemistry factor. Therefore, the limiting ART values from Plate R8-1 could not be exceeded by an updated plate B8628-1 ART value or updated weld ART values. Thus, the original limiting ART value is still valid.

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

c. $\Delta RT_{NDT} = CF * FF$

d. $M = 2 * (\sigma_i^2 + \sigma_\Delta^2)^{1/2}$

e. ART = Initial RT_{NDT} + ΔRT_{NDT} + Margin (°F); (Rounded per ASTM E29, using the "Rounding Method").

f. Data deemed credible per Reference 10 and 12.

g. Neutron Fluence value used for all material is the highest value from Reference 10 for 36 EFPY. It should be noted that the fluence projections from Reference 10 are higher than the updated fluence analysis in Reference 12. See Note "a."

Table 5-7
Summary of the Vogtle Unit 2 Reactor Vessel Beltline Material ART Values

Material	RG 1.99 R2 Method	1/4 ART (°F)	3/4 ART (°F)
Intermediate Shell Plate R4-1	Position 1.1	90	77
Intermediate Shell Plate R4-2	Position 1.1	83	66
Intermediate Shell Plate R4-3	Position 1.1	95	77
Lower Shell Plate B8825-1	Position 1.1	113	96
Lower Shell Plate R8-1	Position 1.1	120	107
Lower Shell Plate B8628-1	Position 1.1	115	97
	Position 2.1	77	70
Intermediate Shell Longitudinal Weld Seams 101-124A, B, C	Position 1.1	81	56
	Position 2.1	25	15
Lower Shell Longitudinal Weld Seams 101-142A, B, C	Position 1.1	81	56
	Position 2.1	25	15
Intermediate to Lower Shell Circ. Weld Seam 101-171	Position 1.1	61	36
	Position 2.1	5	-5

Table 5-8

RT_{PTS} Calculations for Vogtle Unit 2 Beltline Region Materials at 36 EFPY[f]

Material	RG 1.99 R2 Method	CF (°F)	FF	$IRT_{NDT(U)}$[a]	ΔRT_{PTS}[b]	Margin[c]	RT_{PTS}[d]
Intermediate Shell Plate R4-1	Position 1.1	44.0	1.18	10	51.9	34	96
Intermediate Shell Plate R4-2	Position 1.1	37.0	1.18	10	43.7	34	88
Intermediate Shell Plate R4-3	Position 1.1	31.0	1.18	30	36.6	34	101
Lower Shell Plate B8825-1	Position 1.1	37.0	1.18	40	43.7	34	118
Lower Shell Plate R8-1	Position 1.1	44.0	1.18	40	51.9	34	126
Lower Shell Plate B8628-1	Position 1.1	31.0	1.18	50	36.6	34	121
	Position 2.1	20.4	1.18	50	24.1	17[e]	91
Inter. Shell Long. Weld Seams	Position 1.1	43.3	1.18	-10	51.1	51.1	92
101-124A, B, C (0°, 120°, 240° Azimuth)	Position 2.1	21.5	1.18	-10	25.4	25.4[e]	41
Intermediate to Lower Shell Girth Weld Seam 101-171	Position 1.1	43.3	1.18	-30	51.1	51.1	72
	Position 2.1	21.5	1.18	-30	25.4	25.4[e]	21
Lower Shell Long. Weld Seams	Position 1.1	43.3	1.18	-10	51.1	51.1	92
101-142A, B, C (90°, 210°, 330° Azimuth)	Position 2.1	21.5	1.18	-10	25.4	25.4[e]	41

Notes:

a. Initial RT_{NDT} values are measured values.
b. $RT_{PTS} = CF * FF$
c. $M = 2 * (\sigma_i^2 + \sigma_\Delta^2)^{1/2}$
d. $RT_{PTS} = RT_{NDT(U)} + \Delta RT_{PTS} + \text{Margin}$ (°F)
e. Data deemed credible per Reference 10 and 12.
f. Neutron Fluence value used for all materials is the highest interpolated value from Table 5-4 for 36 EFPY.

Table 5-9

RT_{PTS} Calculations for Vogtle Unit 2 Beltline Region Materials at 54 EFPY[f]

Material	RG 1.99 R2 Method	CF (°F)	FF	$IRT_{NDT(U)}$[a]	ΔRT_{PTS}[b]	Margin[c]	RT_{PTS}[d]
Intermediate Shell Plate R4-1	Position 1.1	44.0	1.28	10	56.3	34	100
Intermediate Shell Plate R4-2	Position 1.1	37.0	1.28	10	47.4	34	91
Intermediate Shell Plate R4-3	Position 1.1	31.0	1.28	30	39.7	34	104
Lower Shell Plate B8825-1	Position 1.1	37.0	1.28	40	47.4	34	121
Lower Shell Plate R8-1	Position 1.1	44.0	1.28	40	56.3	34	130
Lower Shell Plate B8628-1	Position 1.1	31.0	1.28	50	39.7	34	124
	Position 2.1	20.4	1.28	50	26.1	17[e]	93
Inter. Shell Long. Weld Seams	Position 1.1	43.3	1.28	-10	55.4	55.4	101
101-124A, B, C (0°, 120°, 240° Azimuth)	Position 2.1	21.5	1.28	-10	27.5	27.5[e]	45
Intermediate to Lower Shell Girth Weld Seam 101-171	Position 1.1	43.3	1.28	-30	55.4	55.4	81
	Position 2.1	21.5	1.28	-30	27.5	27.5[e]	25
Lower Shell Long. Weld Seams	Position 1.1	43.3	1.28	-10	55.4	55.4	101
101-142A, B, C (90°, 210°, 330° Azimuth)	Position 2.1	21.5	1.28	-10	27.5	27.5[e]	45

Notes:

a. Initial RT_{NDT} values are measured values.
b. $\Delta RT_{PTS} = CF * FF$
c. $M = 2 * (\sigma_i^2 + \sigma_\Delta^2)^{1/2}$
d. $RT_{PTS} = RT_{NDT(U)} + \Delta RT_{PTS} + \text{Margin}$ (°F)
e. Data deemed credible per Reference 10 and 12.
f. Neutron Fluence value used for all materials is the highest value from Table 5-4 for 54 EFPY.

6.0 References

1. WCAP-14040-NP-A, Revision 4, "Methodology used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves", J.D. Andrachek, et. al.

2. WCAP-16142-P, Revision 1, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation for Vogtle Units 1 and 2", Warren Bamford, et. al., February 2004.

3. Code of Federal Regulations, 10CFR50, Appendix H, *Reactor Vessel Material Surveillance Program Requirements*, U.S. Nuclear Regulatory Commission, Washington, D.C.

4. WCAP-11381, *Georgia Power Company Alvin W. Vogtle Unit No. 2 Reactor Vessel Radiation Surveillance Program*, L. R. Singer, April 1986.

5. ASTM E23 *Standard Test Method Notched Bar Impact Testing of Metallic Materials*, in ASTM Standards, American Society for Testing and Materials, Philadelphia, PA.

6. ASME Code Case N-640, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves for Section XI, Division 1," February 26, 1999.

7. Section XI of the ASME Boiler and Pressure Vessel Code, Appendix G, *Fracture Toughness Criteria for Protection Against Failure.*

8. ASTM E185-82, Annual Book of ASTM Standards, Section 12, Volume 12.02, *Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels.*

9. Regulatory Guide 1.99, Revision 2, *Radiation Embrittlement of Reactor Vessel Materials*, U.S. Nuclear Regulatory Commission, May 1988.

10. WCAP-15159, *Analysis of Capsule X From the Southern Nuclear Vogtle Electric Generating Plant Unit 2 Reactor Vessel Radiation Surveillance Program*, T.J. Laubham, et. al., dated March 1999. [*Note that the Testing/Analysis reports for surveillance capsules U and Y from Vogtle Unit 2 were documented under WCAP-13007 and WCAP-14532, respectively.*]

11. CVGRAPH, Hyperbolic Tangent Curve-Fitting Program, Version 5.0.2 developed by ATI Consulting, February 2003.

12. WCAP-16382, *Analysis of Capsule W From the Southern Nuclear Operating Company Vogtle Unit 2 Reactor Vessel Radiation Surveillance Program*, T.J. Laubham, et. al., dated January 2005.