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U.S. Nuclear Regulatory Commission
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Southern Nuclear Operating Company
Vogtle Electric Generating Plant Units 3 and 4
Pressurized Thermal Shock (PTS) Evaluation

Ladies and Gentlemen:

In accordance with combined operating license (COL) condition 2.D(12)(g)5 of the Vogtle Electric Generating Plant (VEGP) Units 3 and 4 Combined Licenses, Numbers NPF-91 and NPF-92, respectively, Southern Nuclear Operating Company (SNC) is submitting a copy of the VEGP Units 3 and 4 Pressurized Thermal Shock (PTS) Evaluation.

This letter contains no regulatory commitments. This letter has been reviewed and confirmed to contain no security-related information. Should you have any questions, please contact Mr. Corey Thomas at (205) 992-5221.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 10th day of April 2019.

Respectfully submitted,

SOUTHERN NUCLEAR OPERATING COMPANY

Brian H. Whitley
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Enclosure 1: Vogtle Electric Generating Plant Units 3 and 4 Pressurized Thermal Shock (PTS) Evaluation cc:

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Southern Nuclear Operating Company

ND-19-0356

Enclosure 1

Vogtle Electric Generating Plant Units 3 and 4

Pressurized Thermal Shock (PTS) Evaluation

(This enclosure consists of 7 pages, including this cover page.)

The purpose of this enclosure is to document the required Vogtle Units 3 and 4 reactor vessel (RV) integrity pressurized thermal shock (PTS) compliance with 10 CFR 50.61 [1] and the Vogtle Units 3 and 4 UFSAR (plant-specific DCD) [2] using the measured as-built material properties from the Certified Material Test Reports (CMTRs). This evaluation fulfills Southern Nuclear Operating Company (SNC) combined operating license (COL) Commitment 2.D(12)(g)5. There have been no changes between the approved DCD Rev. 19 document and the current UFSAR Subsections 5.3.3.1 and Tables 5.3-1 and 5.3-3 that would impact the original COL commitment.

The PTS reference temperatures (RT_{PTS}) calculated with the Vogtle Units 3 and 4 actual RV chemical and mechanical properties from the CMTRs are below the RT_{PTS} screening criteria values of 270°F for plates, forgings, and longitudinal welds, and 300°F for circumferential welds at 56 EFPY. This satisfies 10 CFR 50.61 [1] and the UFSAR [2]. A comparison of the plant specific RT_{PTS} values to the screening limits is provided in Table 1. Tables 5 and 6 contain the RT_{PTS} calculations for each of the beltline materials for the Vogtle Units 3 and 4 at 56 effective full power years (EFPY).

The scope of this assessment includes the beltline material for Vogtle Units 3 and 4. The beltline materials are those that will receive a fluence greater than 10^{17} n/cm^2 (E > 1.0 MeV) during the 40-year licensed operating period. For the AP1000® units, the beltline materials include:

- Upper Shell (US) Forging,
- Lower Shell (LS) Forging,
- Transition Ring (TR), and
- the welds connecting these components

The initial RT_{NDT} values and best-estimate Cu and Ni weight % values for the RV beltline materials are provided in Table 2 for Vogtle Unit 3 and in Table 3 for Vogtle Unit 4.

The neutron fluence values used to calculate the RT_{PTS} are provided in Table 4. These fluence values represent the projected fluence at 56 EFPY for Vogtle Units 3 and 4 at clad/base metal interface for RV beltline materials, and are taken from APP-RXS-M3C-026 [3]. The use of 56 EFPY fluence values is conservative compared to a 40-year life, and the 54 EFPY term defined in Table 5.3-3 of the UFSAR [2] for the 60-year design life.

Table 1
Comparison of Plant Specific RT_{PTS} with the Bounding RT_{PTS} Values

Material	RT_{PTS} (°F)		
	Vogtle Unit 3 [Table 5]	Vogtle Unit 4 [Table 6]	10 CFR 50.61 [1] & UFSAR [2]
Upper Shell (US)	29	23	< 270
Lower Shell (LS)	39	19	< 270
Transition Ring (TR)	13	23	< 270
US-to LS-Circumferential (Circ.) Weld	-18	-18	< 300
LS-to-TR Circ. Weld	-13	-13	< 300

Table 2
Material Properties for the Vogtle Unit 3 Reactor Vessel Beltline Materials[a]

Material Description	Chemical Composition[b]		Fracture Toughness Properties
	Cu Wt. %	Ni Wt. %	Initial RT_{NDT}[c] (°F)
US Forging 08W172-1-1	0.03	0.76	-20
LS Forging 09W4-1-1	0.03	0.76	-20
Transition Ring 08D1090-1-1	0.03	0.75	-40
US-to-LS Circumferential Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	0.02	0.02	-70
LS-to-TR Circ. Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	0.02	0.02	-70

Notes for Table 2:
(a) All values were obtained from CMTRs.
(b) The best-estimate chemical composition values listed here are the maximum of the material's product analyses as documented in the CMTRs.
(c) All initial RT_{NDT} values are based on measured data.

Table 3
Material Properties for the Vogtle Unit 4 Reactor Vessel Beltline Materials[a]

Material Description	Chemical Composition[b]		Fracture Toughness Properties
	Cu Wt. %	Ni Wt. %	Initial RT_{NDT}[c] (°F)
US Forging F09173 010	0.04	0.83	-40
LS Forging F09174 010	0.03	0.84	-40
Transition Ring F09175 010	0.03	0.78	-30
US-to-LS Circumferential Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	0.02	0.02	-70
LS-to-TR Circ. Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	0.02	0.02	-70

Notes for Table 3:
(a) All values were obtained from CMTRs.
(b) The best-estimate chemical composition values listed here are the maximum of the material's product analyses as documented in the CMTRs.
(c) All initial RT_{NDT} values are based on measured data.

Table 4
Vogtle Units 3 and 4 Calculated Pressure Vessel Clad/Base Metal Interface Fast Neutron Fluence

Reactor Vessel Material	Fluence, n/cm^2 (E > 1.0 MeV) 56 EFPY[(a)]
US Forging[(b)]	2.24×10^{19}
LS Forging	7.32×10^{19}
Transition Ring[(c)]	3.54×10^{19}
US-to-LS Circ. Weld	2.24×10^{19}
LS-to-TR Circ. Weld	3.54×10^{19}

Notes for Table 4:

(a) All fluence values are taken from APP-RXS-M3C-026, Revision 1 [3].

(b) US Forging fluence value is conservatively deemed equivalent to the US-to LS-Circ. Weld fluence value.

(c) Transition Ring fluence value is conservatively deemed equivalent to the LS-to-TR Circ. Weld fluence value.

Table 5
Calculation of the Vogtle Unit 3 RT_{PTS} Values for 56 EFPY

Reactor Vessel Material	CF[(a)] (°F)	Fluence[(b)] ($x10^{19}$ n/cm^2, E > 1.0 MeV)	FF[(c)]	$RT_{NDT(U)}$[(d)] (°F)	ΔRT_{NDT}[(e)] (°F)	σ_U[(d)] (°F)	σ_Δ[(f)] (°F)	Margin[(g)] (°F)	RT_{PTS}[(h)] (°F)
US Forging 08W172-1-1	20	2.24	1.2184	-20	24.4	0	12.2	24.4	29
LS Forging 09W4-1-1	20	7.32	1.4700	-20	29.4	0	14.7	29.4	39
Transition Ring 08D1090-1-1	20	3.54	1.3292	-40	26.6	0	13.3	26.6	13
US-to-LS Circ. Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	21.5	2.24	1.2184	-70	26.2	0	13.1	26.2	-18
LS-to-TR Circ. Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	21.5	3.54	1.3292	-70	28.6	0	14.3	28.6	-13

Notes for Table 5:

(a) Values determined using the chemical compositions from Table 2 of this letter in conjunction with Tables 1 and 2 of 10 CFR 50.61 [1].

(b) Taken from Table 4 of this letter.

(c) FF = fluence factor = $f^{(0.28 - 0.1 \log (f))}$; per 10 CFR 50.61 [1].

(d) Initial RT_{NDT} values are taken from Table 2 of this letter. All initial RT_{NDT} values are based on material-specific measured data; therefore, σ_U = 0°F consistent with WCAP-14040-A [4].

(e) ΔRT_{NDT} = CF * FF; per 10 CFR 50.61 [1].

(f) Per 10 CFR 50.61 [1], σ_Δ = 17°F for the base metal and σ_Δ = 28°F for the weld metal; however, σ_Δ need not exceed 0.5*ΔRT_{NDT}.

(g) Margin $= 2\sqrt{\sigma_U{}^2 + \sigma_\Delta{}^2}$; per 10 CFR 50.61 [1].

(h) RT_{PTS} values calculated in accordance with 10 CFR 50.61 [1].

Table 6
Calculation of the Vogtle Unit 4 RT_{PTS} Values for 56 EFPY

Reactor Vessel Material	CF[a] (°F)	Fluence[b] ($x10^{19}$ n/cm^2, E > 1.0 MeV)	FF[c]	$RT_{NDT(U)}$[d] (°F)	ΔRT_{NDT}[e] (°F)	σ_U[d] (°F)	σ_Δ[f] (°F)	Margin[g] (°F)	RT_{PTS}[h] (°F)
US Forging F09173 010	26	2.24	1.2184	-40	31.7	0	15.8	31.7	23
LS Forging F09174 010	20	7.32	1.4700	-40	29.4	0	14.7	29.4	19
Transition Ring F09175 010	20	3.54	1.3292	-30	26.6	0	13.3	26.6	23
US-to-LS Circ. Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	21.5	2.24	1.2184	-70	26.2	0	13.1	26.2	-18
LS-to-TR Circ. Weld US-40N (Heat # GZ005499727) with PF-H55SN Flux (Lot # 0KGY610)	21.5	3.54	1.3292	-70	28.6	0	14.3	28.6	-13

Notes for Table 6:

(a) Values determined using the chemical compositions from Table 3 of this letter in conjunction with Tables 1 and 2 of 10 CFR 50.61 [1].

(b) Taken from Table 4 of this letter.

(c) FF = fluence factor = $f^{(0.28 - 0.1 \log (f))}$; per 10 CFR 50.61 [1].

(d) Initial RT_{NDT} values are taken from Table 3 of this letter. All. Initial RT_{NDT} values are based on material-specific measured data; therefore σ_U = 0°F consistent with WCAP-14040-A [4].

(e) ΔRT_{NDT} = CF * FF; per 10 CFR 50.61 [1].

(f) Per 10 CFR 50.61 [1], σ_Δ = 17°F for the base metal and σ_Δ =28°F for the weld metal; however, σ_Δ need not exceed 0.5*ΔRT_{NDT}.

(g) Margin $= 2\sqrt{\sigma_U{}^2 + \sigma_\Delta{}^2}$; per 10 CFR 50.61 [1].

(h) RT_{PTS} values calculated in accordance with 10 CFR 50.61 [1].

References

1. 10 CFR 50.61, “Fracture Toughness Requirements for Protection Against Pressurized Thermal Shock Events,” Federal Register, Volume 60, No. 243, dated December 19, 1995, effective January 18, 1996.
2. Vogtle Units 3 and 4 Updated Final Safety Analysis Report.
3. APP-RXS-M3C-026, “AP1000 Neutron Fast Fluence, DPA, and Heating Rate Evaluation – Long-Term Power Distribution,” Revision 1, April 2012.
4. WCAP-14040-A, “Methodology Used to Develop Cold Overpressure Mitigating System Setpoints and RCS Heatup and Cooldown Limit Curves,” Revision 4, May 2004.