Nuclear Operating Company

South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

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U. S. Nuclear Regulatory Commission
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South Texas Project
Unit 1
Docket No. STN 50-498

Unit 1 Cycle 12 End of Life Moderator Temperature Coefficient Limit Report

As a condition for approval of the conditional elimination of the most negative end of life moderator temperature coefficient measurement technical specification change as stated in the referenced correspondence, STP committed to submit the following information for the first three uses of this methodology at STP:

1. A summary of the plant data used to confirm that the Benchmark Criteria of Table 3-2 of WCAP-13749-P-A, *Safety Evaluation Supporting the Conditional Elimination of the Most Negative EOL Moderator Temperature Coefficient Measurement,* have been met; and,

2. The Most Negative EOL Moderator Temperature Coefficient Limit Report (as found in Appendix D of WCAP-13749-P-A).

The information is attached. This transmittal is the third and final submittal of the three required submittals. If there are any questions regarding this information, please contact Mr. Duane Gore at (361) 972-8909.

D.C. Logan

D.A. Leazar
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Attachments:
1. Plant Data Used to Confirm Benchmark Requirements
2. Most Negative End of Life Moderator Temperature Coefficient Limit Report for South Texas Unit 1, Cycle 12

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cc:
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Attachment 1

Plant Data
Used to Confirm Benchmark Requirements

Plant Data Used to Confirm Benchmark Requirements are Satisfied

This attachment presents a comparison of the South Texas Unit 1 Cycle 12 core characteristics with the requirements for use of the Conditional Exemption of the Most Negative EOL Moderator Temperature Coefficient Measurement Methodology and presents plant data that support that the Benchmark Criteria presented in WCAP-13749-P-A are met.

The Conditional Exemption of the Most Negative EOL Moderator Temperature Coefficient Measurement Methodology is described in WCAP-13749-P-A. This report was approved by the NRC with two requirements:

- only PHOENIX/ANC calculation methods are used for the individual plant analyses relevant to determinations for the EOL MTC plant methodology, and
- the predictive correction is reexamined if changes in core fuel designs or continued MTC calculation/measurement data show significant effect on the predictive correction.

The PHOENIX/ANC calculation methods were used for the South Texas Unit 1, Cycle 12, core design and relevant analyses. Also, the Unit 1, Cycle 12, core design does not represent a major change in core fuel design. Therefore, the Predictive Correction of –3 pcm/°F remains valid for this cycle. The Unit 1, Cycle 12, core meets both of the above requirements.

A description of the data collection and calculations required to complete the Table 3 Worksheet of the Most Negative Moderator Temperature Coefficient Limit Report is presented in Attachment 2. Then the following data tables are provided in this attachment:

- Table 1 - Benchmark Criteria for Application of the 300 ppm MTC Conditional Exemption Methodology (per WCAP-13749-P-A)
- Table 2 - Flux Map Data: Assembly Powers and Core Tilt Criteria
- Table 3 - Core Reactivity Balance Data
- Table 4 - Low Power Physics Test Data (Beginning of Cycle, Hot Zero Power): Isothermal Temperature Coefficient (ITC)
- Table 5 - Low Power Physics Test Data (Beginning of Cycle, Hot Zero Power): Individual Control Bank Worth

Table 1
Benchmark Criteria for Application of the 300 ppm MTC Conditional Exemption Methodology (per WCAP-13749-P-A)

Parameter	Criteria
Assembly Power (Measured Normal Reaction Rate)	± 0.1 or 10 %
Measured Incore Quadrant Power Tilt (Low Power)	± 4 %
Measured Incore Quadrant Power Tilt (Full Power)	± 2 %
Core Reactivity (Cb) Difference	± 1000 pcm
BOL HZP ITC	± 2 pcm/°F
Individual Control Bank Worth	± 15 % or ± 100 pcm
Total Control Bank Worth	± 10 %

Table 2
Page 1 of 2
Flux Map Data:Assembly Powers and Core Tilt Criteria

Flux Map Number	Assembly Power				Measured Incore Quadrant Power Tilt			
	Measured to Predicted Error		Benchmark Criteria		Power Tilt		Benchmark Criteria	
			Requirement	Criteria Satisfied			Requirement	Criteria Satisfied
112001	% Diff	5.9	% Diff within ± 10% OR M-P within ± 0.1	Yes	Max	1.00485	Maps at < 90% Reactor Power: Max Power Tilt ≤ 1.04 And Min Power Tilt ≥ 0.96 OR Maps at > 90% Reactor Power: Max Power Tilt ≤ 1.02 And Min Power Tilt ≥ 0.98	Yes
	M-P	-0.080			Min	0.99463		
112002	% Diff	4.7		Yes	Max	1.00305		Yes
	M-P	-0.051			Min	0.99710		
112007	% Diff	5.2		Yes	Max	1.00628		Yes
	M-P	-0.048			Min	0.99263		
112008	% Diff	5.3		Yes	Max	1.00714		Yes
	M-P	-0.052			Min	0.99262		
112009	% Diff	5.2		Yes	Max	1.00878		Yes
	M-P	-0.049			Min	0.98994		
112010	% Diff	5.0		Yes	Max	1.00772		Yes
	M-P	-0.047			Min	0.99071		
112015	% Diff	4.5		Yes	Max	1.00535		Yes
	M-P	-0.045			Min	0.99319		
112016	% Diff	4.1		Yes	Max	1.00457		Yes
	M-P	-0.040			Min	0.99509		
112017	% Diff	4.0		Yes	Max	1.00155		Yes
	M-P	-0.035			Min	0.99679		
112018	% Diff	3.9		Yes	Max	1.00359		Yes
	M-P	-0.036			Min	0.99622		
112019A	% Diff	4.0		Yes	Max	1.00425		Yes
	M-P	-0.034			Min	0.99669		
112020	% Diff	3.9		Yes	Max	1.00500		Yes
	M-P	-0.035			Min	0.99611		
112021	% Diff	4.2		Yes	Max	1.00434		Yes
	M-P	-0.035			Min	0.99585		
112022	% Diff	4.4		Yes	Max	1.00634		Yes
	M-P	-0.039			Min	0.99530		
112023	% Diff	4.5		Yes	Max	1.00547		Yes
	M-P	-0.037			Min	0.99574		
112024	% Diff	4.7		Yes	Max	1.00507		Yes
	M-P	-0.044			Min	0.99655		
112025	% Diff	5.8		Yes	Max	1.00677		Yes
	M-P	0.042			Min	0.99451		

Table 2
Page 2 of 2
Flux Map Data:Assembly Powers and Core Tilt Criteria

Flux Map Number	Assembly Power				Measured Incore Quadrant Power Tilt			
	Measured to Predicted Error		Benchmark Criteria				Benchmark Criteria	
			Requirement	Criteria Satisfied	Power Tilt		Requirement	Criteria Satisfied
112026	% Diff	6.7	% Diff within ± 10% OR M-P within ± 0.1	Yes	Max	1.00603	See Note 1	Yes
	M-P	0.046			Min	0.99605		
112027	% Diff	6.5		Yes	Max	1.00491		Yes
	M-P	0.045			Min	0.99734		
112028	% Diff	6.8		Yes	Max	1.00491		Yes
	M-P	0.047			Min	0.99667		

Note 1: **Maps at < 90% Reactor Power**
Max Power Tilt ≤ 1.04 And Min Power Tilt ≥ 0.96

OR

Maps at > 90% Reactor Power
Max Power Tilt ≤ 1.02 And Min Power Tilt ≥ 0.98

Table 3
Core Reactivity Balance Data

Surveillance Date/Time		Core Reactivity Difference (Critical boron)		
		Reactivity Deviation (pcm)	Benchmark Criteria	
			Requirement	Satisfied
8/15/03	12:38	116.7	Reactivity Deviation within ± 1000 pcm	Yes
8/26/03	14:45	57.5		Yes
9/23/03	15:43	-102.6		Yes
10/21/03	13:30	-197.1		Yes
11/18/03	14:52	-246.8		Yes
12/16/03	14:00	-322.1		Yes
1/13/04	15:12	-393.7		Yes
2/11/04	15:44	-337.5		Yes
3/3/04	14:48	-373.6		Yes
4/2/04	9:09	-401.32		Yes
5/5/04	15:34	-430.7		Yes
6/2/04	9:56	-381.7		Yes
6/29/04	16:30	-389.7		Yes
7/27/04	15:53	-379.1		Yes
8/25/04	10:14	-314.1		Yes
9/21/04	15:46	-189.7		Yes
10/19/04	14:40	-122.3		Yes
11/16/04	14:28	-25.42		Yes

Table 4
Low Power Physics Test Data
(Beginning of Cycle, Hot Zero Power):
Isothermal Temperature Coefficient (ITC)

	Measured (pcm/°F)*	Predicted (pcm/°F)*	Error (Measured – Predicted) (pcm/°F)*	Benchmark Criteria	
				Requirement	Satisfied
BOC HZP ITC	-2.70	-2.32	-0.38	ITC Error within ±2 pcm/°F	Yes

*Note: 1 pcm = 1 x 10^{-5} ΔK/K

Table 5
Low Power Physics Test Data
(Beginning of Cycle, Hot Zero Power):
Individual Control Bank Worth

Bank	Measured (pcm)*	Predicted (pcm)*	Δ Error (pcm)*	% Error	Benchmark Criteria	
					Requirement	Satisfied
Shutdown Bank A	307.1	288.5	18.6	6.4	% Error within ±15% OR Δ Error within ±100 pcm	Yes
Shutdown Bank B	898.8	912.6	-13.8	-1.5		Yes
Shutdown Bank C	457.1	442.0	15.1	3.4		Yes
Shutdown Bank D	465.3	441.1	24.2	5.5		Yes
Shutdown Bank E	448.1	469.2	-21.1	-4.5		Yes
Control Bank A	646.9	676.2	-29.3	-4.3		Yes
Control Bank B	788.9	749.1	39.8	5.3		Yes
Control Bank C	700.6	710.9	-10.3	-1.5		Yes
Control Bank D	558.9	541.9	17	3.1		Yes
Total Control Bank Worth	5271.7	5231.5	40.2	0.77	% Error within ±10%	Yes

*Note: 1 pcm = 1 x 10^{-5} ΔK/K

Attachment 2

Most Negative End of Life Moderator Temperature Coefficient Limit Report for South Texas Unit 1, Cycle 12

Most Negative End of Life Moderator Temperature Coefficient Limit Report for South Texas Unit 1, Cycle 12

(Measured 300 ppm Burnup, as per WCAP-13749-P-A, Appendix D)

PURPOSE:

The purpose of this document is to present cycle-specific best estimate data for use in confirming the most negative end of life moderator temperature coefficient (MTC) limit in Technical Specification 3.1.1.3. This document also summarizes the methodology used for determining if a HFP 300 ppm MTC measurement is required.

PRECAUTIONS AND LIMITATIONS:

The EOL MTC elimination data presented in this document apply to South Texas Unit 1 Cycle 12 only and may not be used for other operating cycles.

The following reference is applicable to this document:

Fetterman, R. J., Slagle, W. H., *Safety Evaluation Supporting the Conditional Exemption of the Most Negative EOL Moderator Temperature Coefficient Measurement*, WCAP-13749-P-A, March, 1997.

PROCEDURE:

All core performance benchmark criteria listed in Table 1 must be met for the current operating cycle. These criteria are confirmed from startup physics test results and routine HFP boron concentration and flux map surveillance performed during the cycle.

If all core performance benchmark criteria are met, then the Revised Predicted MTC may be calculated per the algorithm given in Table 2. The required cycle specific data are provided in Table 2 and Figure 1. This methodology is also described in the above Reference. If all core performance benchmark criteria are met, and the Revised Predicted MTC is less negative than the 300 ppm limit specified in COLR Section 2.4.3, then a measurement is not required.

Note that Figure 1 is not entirely linear. However, the deviation is slight enough that linear interpolation between adjacent points from the data at the bottom of the Figure is acceptable.

Table 1
Benchmark Criteria for Application of the 300 ppm MTC
Conditional Exemption Methodology

Parameter	Criteria
Assembly Power (Measured Normal Reaction Rate)	± 0.1 or 10 %
Measured Incore Quadrant Power Tilt (Low Power)	± 4 %
Measured Incore Quadrant Power Tilt (Full Power)	± 2 %
Core Reactivity (Cb) Difference	± 1000 pcm
BOL HZP ITC	± 2 pcm/°F
Individual Control Bank Worth	± 15 % or ± 100 pcm
Total Control Bank Worth	± 10 %

Table 2
Algorithm for Determining the Revised Predicted Near-EOL 300 ppm MTC

The Revised Predicted MTC = Predicted MTC + AFD Correction – 3 pcm/°F where:

Predicted MTC is calculated from Figure 1 at the burnup corresponding to the measurement of 300 ppm at RTP conditions,

AFD Correction is the more negative value of:

{ 0 pcm/°F, (ΔAFD * AFD Sensitivity) }

ΔAFD is the measured AFD minus the predicted AFD from an incore flux map taken at or near the burnup corresponding to 300 ppm.

AFD Sensitivity = 0.05 pcm / °F / ΔAFD

Predictive Correction is –3 pcm/°F, as included in the equation for the Revised Predicted MTC.

Table 3
Worksheet for Calculating the Predicted Near-EOL 300 ppm MTC

Unit: 1, Cycle 12 **Date:** 11/22/2004 **Time:** 1012

Reference for Cycle-Specific MTC Data:

A41009-00548UB Rev.A, The Nuclear Design and Core Management of the South Texas Unit 1 Nuclear Power Plant Cycle 12 Redesign.

Part A. Predicted MTC

A.1	Cycle Average Burnup Corresponding to the HFP ARO equilibrium xenon C_B of 300 ppm.	17452.8	MWD/MTU
A.2	Predicted HFP ARO MTC corresponding to burnup (A.1)	-35.24	pcm/°F

Part B. AFD Correction

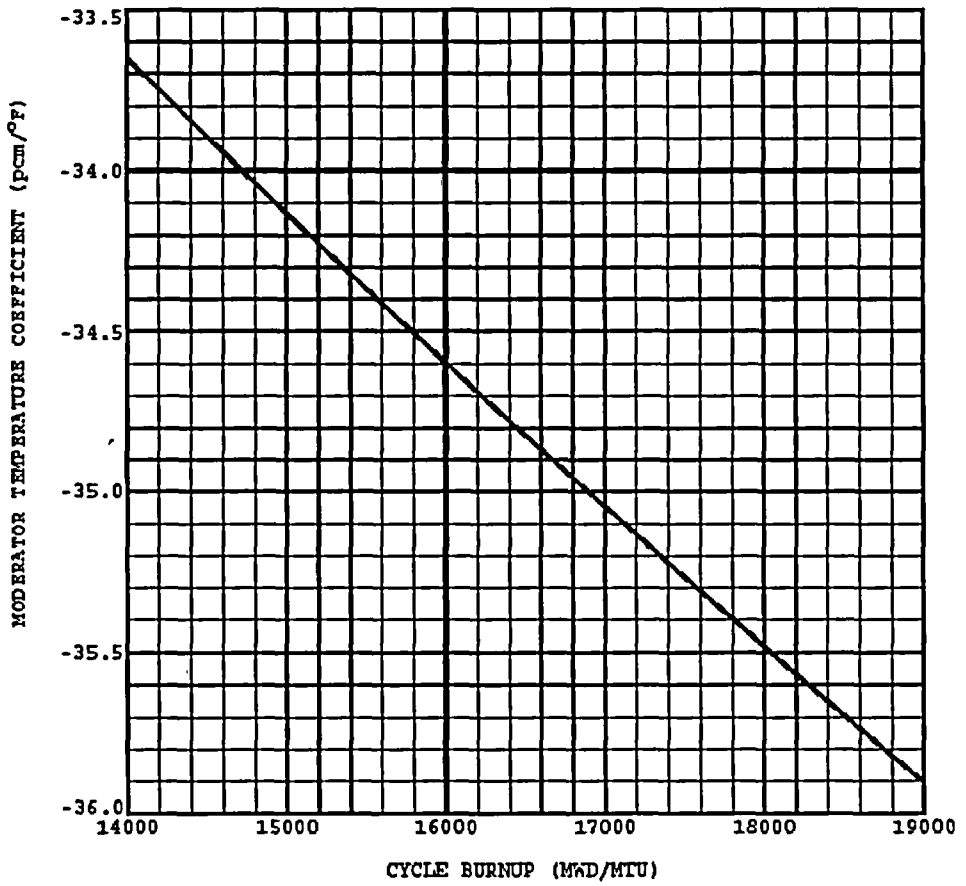
B.1	Burnup of most recent HFP, equilibrium conditions incore flux map	17238.0	MWD/MTU
B.2	Measured HFP AFD at burnup (B.1) Reference incore flux map: ID: 112028 Date: 11/16/04	-2.06	% AFD
B.3	Predicted HFP AFD at burnup (B.1)	-2.54	% AFD
B.4	MTC Sensitivity to AFD	0.05	pcm/°F/ΔAFD
B.5	AFD Correction, more negative of { 0 pcm/°F, B.4 *(B.2 – B.3)}	0	pcm/°F

Part C. Revised Prediction

C.1	Revised Prediction (A.2 + B.5 – 3)	-38.24	pcm/°F
C.2	Surveillance Limit (COLR 2.3.3)	-53.72	pcm/°F

If C.1 is less negative than C.2, then the HFP 300 ppm MTC measurement is not required per Specification 4.1.1.3.

Figure 1
Predicted HFP FOP 300 ppm MTC vs. Cycle 12 Redesign Burnup



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficients (pcm/°F)
14000	-33.65
16000	-34.60
17000	-35.05
19000	-35.91

Table 4
Data Collection and Calculations Required to Complete the Table 3 Worksheet of the Most Negative Moderator Temperature Coefficient Limit Report

Data at the 300 ppm Boron Point

- RCS Boron at 300 ppm at 02:35 on 11/22/04.
- Burnup at 300 ppm: 17452.8 MWD/MTU **(A.1)**
- Predicted MTC: -35.24 pcm/°F **(A.2)**

Data from Last Flux Map:

- Flux Map Number: 112028 **(B.2)**
- Reactor Power 100% RTP
  Note: The monthly flux map was performed about a week before the unit reached the 300 ppm concentration value. Data from this flux map was used for the AFD Correction.
- Burnup 17238.0 MWD/MTU **(B.1)**
- Measured Axial Offset (MAO): -2.06% **(B.2)**
  Note: The Westinghouse BEACON computer code (similar to the Westinghouse INCORE code) determines Axial Offset (AO), not Axial Flux Difference (AFD). Therefore, the AO must be converted to AFD before use. The relationship between AO and AFD is

AFD = Axial Offset * Fractional Power

- Axial Flux Difference
  Lower Predicted AO (LPAO): -2.35% at 16000 MWD/MTU
  Higher Predicted AO (HPAO): -2.73% at 18500 MWD/MTU
  Predicted AO (PAO) =

$$PAO = \frac{B/U_{@Measued\ AO} - B/U_{@LowerPredicted\ AO}}{B/U_{@HigherPredicted\ AO} - B/U_{@LowerPredicted\ AO}} \times (HPAO - LPAO) + LPAO$$

PAO = (17238.0 – 16000)/(18500 – 16000) * (-2.73% + 2.35%) - 2.35% = -2.54% **(B.3)**

Δ AFD = (MAO-PAO) * (Reactor Power (%) / 100%)
= (-2.06% + 2.54%) * (100% / 100%)
= 0.48%

Table 4 (cont.)
Data Collection and Calculations Required to Complete the Table 3 Worksheet of the Most Negative Moderator Temperature Coefficient Limit Report

Determination of the Revised Predicted Moderator Temperature Coefficient (MTC)

AFD Sensitivity: 0.05 pcm/°F/ ΔAFD

AFD Correction: 0 pcm/°F **(B.5)**

where: AFD Correction is the more negative of the following:

0 pcm/°F or (ΔAFD * AFD Sensitivity)

0 pcm/°F or (0.48 * 0.05 pcm/°F/ ΔAFD)

0 pcm/°F or 0.024 pcm/°F

∴ 0 pcm/°F

Revised Predicted MTC = Predicted MTC + AFD Correction - 3 pcm/°F

= -35.24 pcm/°F + 0.0 pcm/°F – 3 pcm/°F

= -38.24 pcm/°F **(C.1)**