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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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11555 Rockville Pike
Rockville, MD 20852

South Texas Project
Unit 2
Docket No. STN 50-499
Unit 2 Cycle 10 End of Life Moderator Temperature Coefficient Limit Report

Reference: Letter, J. J. Sheppard to U.S. Nuclear Regulatory Commission, "End of Life Moderator Temperature Coefficient," dated October 31, 2002 (NOC-AE-02001425)

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 second of the three submittals. The results of the Unit 1, Cycle 11 surveillance were transmitted on January 13, 2003. If there are any questions regarding this information, please contact Mr. Duane Gore at (361) 972-8909.

D.A. Leazar
D.A. Leazar
Manager,
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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 2, Cycle 10

A001

cc:

(paper copy)

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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 2 Cycle 10 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 2, Cycle 10, core design and relevant analyses. Also, the Unit 2, Cycle 10, 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 2, Cycle 10, 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. Then the following data tables are provided:

- 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
Flux Map Data: Assembly Powers and Core Tilt Criteria

Flux Map Number	Assembly Power: Measured to Predicted Error		Benchmark Criteria: Requirement	Benchmark Criteria: Criteria Satisfied	Measured Incore Quadrant Power Tilt: Power Tilt		Benchmark Criteria: Requirement	Benchmark Criteria: Criteria Satisfied
210001	% Diff	4.5	% Diff within ± 10% **OR** M-P within ± 0.1	Yes	Max	1.00648	**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
	Meas – Pred	0.053			Min	0.99172		
210002	% Diff	4.1		Yes	Max	1.00507		Yes
	Meas – Pred	0.052			Min	0.99358		
210003	% Diff	4.0		Yes	Max	1.00572		Yes
	Meas - Pred	0.051			Min	0.99282		
210004	% Diff	3.7		Yes	Max	1.00565		Yes
	Meas - Pred	0.045			Min	0.99430		
210005	% Diff	3.2		Yes	Max	1.00506		Yes
	Meas - Pred	0.038			Min	0.99504		
210006	% Diff	3.2		Yes	Max	1.00302		Yes
	Meas - Pred	0.038			Min	0.99744		
210007	% Diff	3.3		Yes	Max	1.00108		Yes
	Meas - Pred	-0.034			Min	0.99899		
210008	% Diff	3.3		Yes	Max	1.00122		Yes
	Meas - Pred	-0.031			Min	0.99873		
210009	% Diff	4.0		Yes	Max	1.00244		Yes
	Meas - Pred	0.034			Min	0.99891		
210010	% Diff	4.6		Yes	Max	1.00394		Yes
	Meas - Pred	0.040			Min	0.99846		
210011	% Diff	4.2		Yes	Max	1.00204		Yes
	Meas - Pred	0.036			Min	0.99885		
210012	% Diff	4.7		Yes	Max	1.00282		Yes
	Meas - Pred	0.038			Min	0.99667		
210013	% Diff	4.9		Yes	Max	1.00762		Yes
	Meas - Pred	-0.042			Min	0.99433		
210014	% Diff	5.2		Yes	Max	1.00566		Yes
	Meas - Pred	0.043			Min	0.99714		
210015	% Diff	4.7		Yes	Max	1.00368		Yes
	Meas - Pred	0.041			Min	0.99585		
210016	% Diff	4.8		Yes	Max	1.00571		Yes
	Meas - Pred	0.041			Min	0.99530		
210017	% Diff	5.5		Yes	Max	1.00453		Yes
	Meas - Pred	0.045			Min	0.99780		

Table 3
Core Reactivity Balance Data

Surveillance Date/Time		Core Reactivity Difference (Critical boron)		
		Reactivity Deviation (pcm)	Benchmark Criteria	
			Requirement	Satisfied
12/12/02	13:51	143.4	Reactivity Deviation within ± 1000 pcm	Yes
04/09/03	15:00	-0.6		Yes
04/29/03	15:15	-96.1		Yes
05/06/03	15:53	-110.0		Yes
05/28/03	09:00	-113.7		Yes
06/25/03	16:45	-200.3		Yes
07/25/03	11:25	-293.2		Yes
08/20/03	15:33	-325.9		Yes
09/17/03	15:32	-329.1		Yes
10/08/03	16:22	-348.1		Yes
11/05/03	16:00	-344.5		Yes
12/09/03	07:56	-323.8		Yes
12/30/03	14:33	-169.6		Yes
01/29/04	11:25	-122.1		Yes
02/18/04	13:55	-103.9		Yes
03/17/04	14:55	-46.3		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	-2.43	-3.12	0.69	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	241.2	243.9	-2.7	-1.1%	% Error within ±15% OR Δ Error within ±100 pcm	Yes
Shutdown Bank B	690.0	715.7	-25.7	-3.6%		Yes
Shutdown Bank C	381.7	377.3	4.4	1.2%		Yes
Shutdown Bank D	378.1	371.2	6.9	1.9%		Yes
Shutdown Bank E	479.7	472.2	7.5	1.6%		Yes
Control Bank A	903.9	890.5	13.4	1.5%		Yes
Control Bank B	599.8	586.2	13.6	2.3%		Yes
Control Bank C	797.7	792.2	5.5	0.7%		Yes
Control Bank D	494.1	479.3	14.8	3.1%		Yes
Total Control Bank Worth	4966.2	4928.5	37.7	0.8%	% 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 2, Cycle 10

Most Negative End of Life Moderator Temperature Coefficient Limit Report for South Texas Unit 2, Cycle 10

(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 2 Cycle 10 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 Reference 1. If all core performance benchmark criteria are met, and the Revised Predicted MTC is less negative than COLR Limit 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: 2, Cycle 10 **Date:** 03/18/2004 **Time:** 0027

Reference for Cycle-Specific MTC Data:

A41010-00533UB Rev.C, The Nuclear Design and Core Management of the South Texas Unit 2 Nuclear Power Plant Cycle 10.

Part A. Predicted MTC

A.1	Cycle Average Burnup Corresponding to the HFP ARO equilibrium xenon C_B of 300 ppm.	14251.0	MWD/MTU
A.2	Predicted HFP ARO MTC corresponding to burnup (A.1)	-35.5	pcm/°F

Part B. AFD Correction

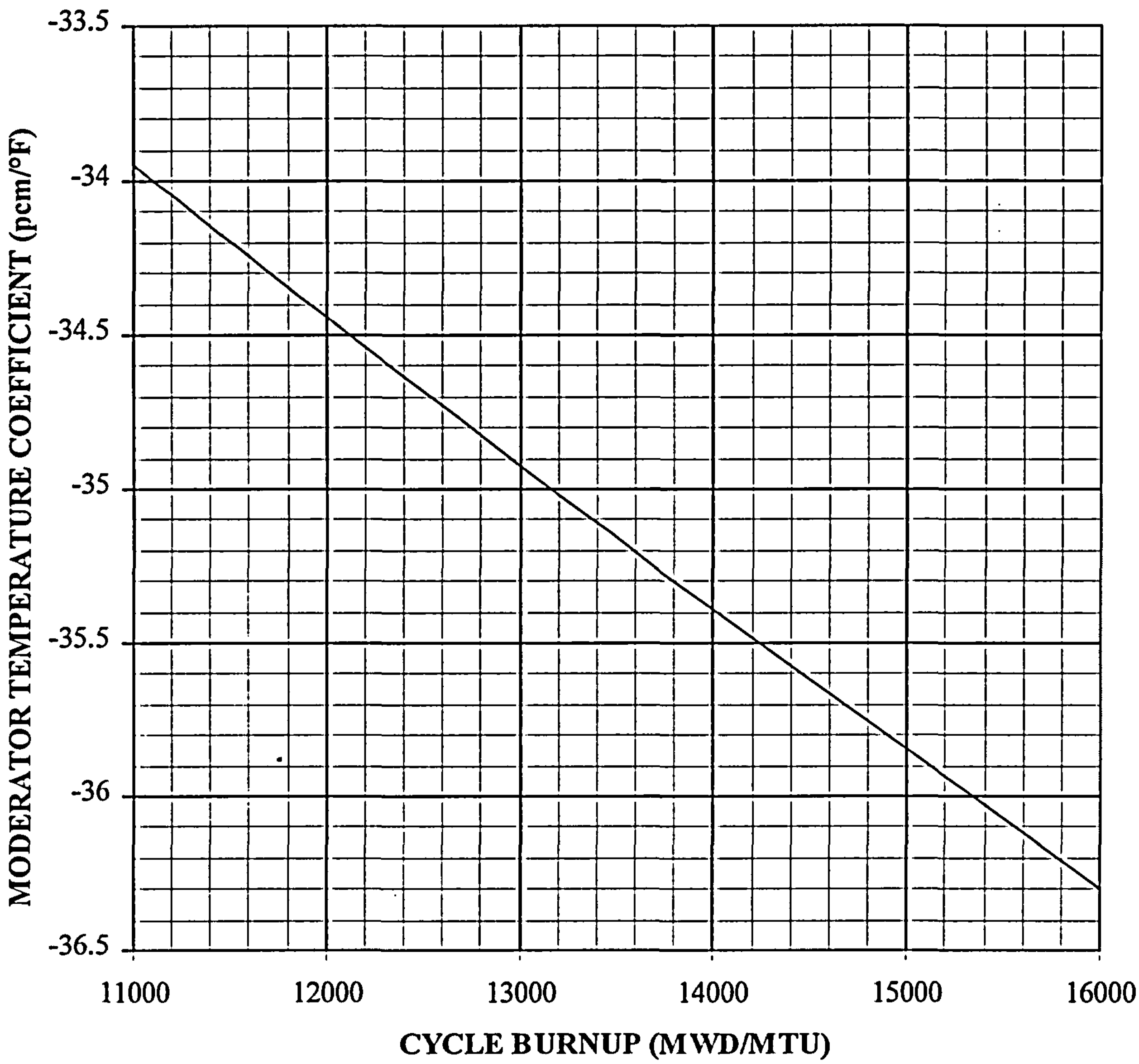
B.1	Burnup of most recent HFP, equilibrium conditions incore flux map	14226.8	MWD/MTU
B.2	Measured HFP AFD at burnup (B.1) Reference incore flux map: ID: 210017 Date: 03/17/04	-1.59	% AFD
B.3	Predicted HFP AFD at burnup (B.1)	-2.62	% AFD
B.4	MTC Sensitivity to AFD	0.05	pcm/°F/ΔAFD
B.5	AFD Correction, 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)	-38.5	pcm/°F
C.2	Surveillance Limit (COLR 2.3.3)	-53.6	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
<u>Predicted HFP FOP 300 ppm MTC vs. Cycle 10 Burnup</u>



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficients (pcm/°F)
11000	-33.95
12000	-34.44
14000	-35.39
16000	-36.30

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 00:27 on 03/18/04.
- Burnup at 300 ppm: 14251.0 MWD/MTU **(A.1)**
- Predicted MTC: -35.5 pcm/°F **(A.2)**

Data from Last Flux Map:

- Flux Map Number: 210017 **(B.2)**
- Reactor Power 100% RTP
  Note: The monthly flux map was performed at about the same time the unit reached the 300 ppm concentration value. Data from this flux map was used for the AFD Correction.
- Burnup 14226.8 MWD/MTU **(B.1)**
- Measured Axial Offset (MAO): -1.59% **(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): -2.58% at 14000 MWD/MTU
  Higher Predicted AO (HPAO): -2.89% at 16000 MWD/MTU
  Predicted AO (PAO) =

$$PAO=\frac{B/U_{@Measured\,AO}-B/U_{@Lower\,Predicted\,AO}}{B/U_{@Higher\,Predicted\,AO}-B/U_{@Lower\,Predicted\,AO}}\times(HPAO-LPAO)+LPAO$$

PAO = (14251.0 – 14000)/(16000 – 14000) * (-2.89% + 2.58%) - 2.58% = -2.62% **(B.3)**

Δ AFD = (MAO-PAO) * 100%
= (-1.59% + 2.62%) * 100%
= 1.03%

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 (1.03% * 0.05 pcm/°F/ ΔAFD)

0 pcm/°F or 0.052 pcm/°F

∴ 0 pcm/°F

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

= -35.5 pcm/°F + 0.0 pcm/°F – 3 pcm/°F

= -38.5 pcm/°F **(C.1)**