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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, DC 20555-0001

Donald C. Cook Nuclear Plant Unit 1
Unit 1 Cycle 21 End of Life Moderator Temperature Coefficient Limit Report

Reference: Letter from J. N. Jensen, Indiana Michigan Power Company, to U. S. Nuclear Regulatory Commission Document Control Desk, "Supplement to License Amendment Request on the Conditional Exemption from Measurement of End of Life Moderator Temperature Coefficient," AEP:NRC:5132-01, dated June 2, 2005.

Indiana Michigan Power Company, the licensee for the Donald C. Cook Nuclear Plant (CNP), made a commitment in the referenced letter to submit the following information for the first three uses of the WCAP-13749-P-A methodology for each unit at CNP as a condition for approval of the conditional exemption of the most negative end of life moderator temperature coefficient measurement technical specification change:

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 Exemption of the Most Negative EOL Moderator Temperature Coefficient Measurement,* have been met; and,

2. The Most Negative 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 for Unit 1. There are no new or revised commitments made in this submittal.

A001
NRR

Should you have any questions, please contact Mr. James M. Petro, Jr., Regulatory Affairs Manager, at (269) 466-2491.

Sincerely,

Joseph N. Jensen
Site Support Services Vice President

RSP/rdw

Attachments:

1. Plant Data Used to Confirm Benchmark Requirements
2. Most Negative End of Life Moderator Temperature Coefficient Limit Report for Donald C. Cook Nuclear Plant Unit 1, Cycle 21

c: J. L. Caldwell, NRC Region III
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Attachment 1 to AEP:NRC:8132

PLANT DATA USED TO CONFIRM BENCHMARK REQUIREMENTS

Plant Data Used to Confirm Benchmark Requirements

To facilitate the review of this information, a list of acronyms used in this attachment is provided.

°F	degrees Fahrenheit
%	percent
BOL	beginning of life
CNP	Donald C. Cook Nuclear Plant
EOL	end of life
HZP	hot zero power
ITC	isothermal temperature coefficient
M	measured
MTC	moderator temperature coefficient
MTU	metric tons of uranium
MWD	megawatt-day
NRC	Nuclear Regulatory Commission
pcm	percent-millirho
P	predicted

This attachment presents a comparison of the CNP Unit 1 Cycle 21 core characteristics with the requirements for use of the Conditional Exemption of the Most Negative EOL MTC Measurement methodology and presents plant data demonstrating that the Benchmark Criteria presented in WCAP-13749-P-A are met.

The Conditional Exemption of the Most Negative EOL MTC 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 CNP Unit 1 Cycle 21 core design and relevant analyses. Also, the Unit 1 Cycle 21 core design does not represent a major change in core fuel design and the MTC calculation-to-measurement physics database shows no significant effect on the predictive correction. Therefore, the predictive correction of -3 pcm/°F remains valid for this cycle. The Unit 1 Cycle 21 core meets both of the above requirements.

The following data tables are provided in support of the benchmark criteria:

- 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
- Table 3 - Flux Map Data: Core Tilt Criteria
- Table 4 - Core Reactivity Balance Data
- Table 5 - Low Power Physics Test Data (BOL, HZP): ITC
- Table 6 - Low Power Physics Test Data (BOL, HZP): Total 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 Difference	± 1000 pcm
BOL HZP ITC	± 2 pcm/°F
Individual Control Bank Worth	NA*
Total Control Bank Worth	± 10 %

* Not required when "The Spatially Corrected Inverse Count Rate (SCICR) Method for Subcritical Reactivity Measurement" has been performed; see letter from J. D. St. John, Westinghouse Electric Company, to M. L. Bellville, American Electric Power Nuclear Generation Group, "NRC Staff Interpretation of WCAP-16260-P-A," NF-AE-06-72, dated May 30, 2006.

Table 2

Flux Map Data: Assembly Powers

Assembly Power Determination

Map	Date	Power (%)	(Maximum Magnitude of Relative Error)				
			Measured Power	Predicted Power	|Predicted - Measured|	10% of Predicted	Acceptable
121-01	11/14/06	23.99	0.428	0.397	0.031	0.040	YES
121-02	11/15/06	46.71	1.174	1.109	0.065	0.111	YES
121-03	11/17/06	87.15	0.347	0.330	0.017	0.033	YES
121-04	*	*	*	*	*	*	*
121-05	*	*	*	*	*	*	*
121-06	11/18/06	97.43	0.353	0.332	0.021	0.033	YES
121-07	11/20/06	99.93	0.351	0.332	0.019	0.033	YES
121-08	11/22/06	99.95	0.352	0.331	0.021	0.033	YES
121-09	11/27/06	99.90	0.439	0.415	0.024	0.042	YES
121-10	12/11/06	99.85	0.352	0.329	0.023	0.033	YES
121-11	01/15/07	99.84	0.347	0.326	0.021	0.033	YES
121-12	02/12/07	99.87	0.343	0.325	0.018	0.033	YES
121-13	03/12/07	99.84	0.447	0.422	0.025	0.042	YES
121-14	04/16/07	99.91	0.345	0.327	0.018	0.033	YES
121-15	05/14/07	99.86	1.159	1.099	0.060	0.110	YES
121-16	*	*	*	*	*	*	*
121-17	06/11/07	99.89	0.353	0.334	0.019	0.033	YES
121-18	07/16/07	99.85	0.359	0.340	0.019	0.034	YES
121-19	08/13/07	99.95	0.367	0.346	0.021	0.035	YES
121-20	09/10/07	99.87	0.372	0.351	0.021	0.035	YES
121-21	10/15/07	99.89	0.381	0.359	0.022	0.036	YES
121-22	11/12/07	99.86	0.387	0.365	0.022	0.037	YES
121-23	12/10/07	99.88	0.396	0.370	0.026	0.037	YES

Acceptance Criteria: ± 0.1 or 10%.

* Flux maps 121-04, 121-05, and 121-16 were not full core flux maps. As a result, they do not constitute a valid measurement of the indicated parameter.

Table 3

Flux Map Data: Core Tilt Criteria

Top Half Incore Quadrant Power Tilt

Map #	Power (%)	Maximum Tilt	Minimum Tilt	Acceptable
121-01	23.99	1.00695	0.99487	Yes
121-02	46.71	1.00437	0.99418	Yes
121-03	87.15	1.00608	0.99498	Yes
121-04	*	*	*	*
121-05	*	*	*	*
121-06	97.43	1.00445	0.99551	Yes
121-07	99.93	1.00504	0.99533	Yes
121-08	99.95	1.00402	0.99623	Yes
121-09	99.90	1.00486	0.99507	Yes
121-10	99.85	1.00560	0.99446	Yes
121-11	99.84	1.00345	0.99717	Yes
121-12	99.87	1.00202	0.99631	Yes
121-13	99.84	1.00186	0.99607	Yes
121-14	99.91	1.00158	0.99679	Yes
121-15	99.86	1.00152	0.99752	Yes
121-16	*	*	*	*
121-17	99.89	1.00207	0.99579	Yes
121-18	99.85	1.00302	0.99546	Yes
121-19	99.95	1.00260	0.99579	Yes
121-20	99.87	1.00344	0.99345	Yes
121-21	99.89	1.00324	0.99275	Yes
121-22	99.86	1.00454	0.99531	Yes
121-23	99.88	1.00479	0.99183	Yes

Acceptance Criteria: **High power maps - maximum power tilt: 1.02; minimum power tilt: 0.98**
Low power maps - maximum power tilt: 1.04; minimum power tilt: 0.96

* Flux maps 121-04, 121-05, and 121-16 were not full core flux maps. As a result, they do not constitute a valid measurement of the indicated parameter.

Table 3 (continued)

Flux Map Data: Core Tilt Criteria

Bottom Half Incore Quadrant Power Tilt

Map #	Power (%)	Maximum Tilt	Minimum Tilt	Acceptable
121-01	23.99	1.00702	0.99307	Yes
121-02	46.71	1.00484	0.99327	Yes
121-03	87.15	1.00230	0.99608	Yes
121-04	*	*	*	*
121-05	*	*	*	*
121-06	97.43	1.00391	0.99654	Yes
121-07	99.93	1.00473	0.99521	Yes
121-08	99.95	1.00595	0.99393	Yes
121-09	99.90	1.00384	0.99463	Yes
121-10	99.85	1.00348	0.99456	Yes
121-11	99.84	1.00405	0.99364	Yes
121-12	99.87	1.00533	0.99565	Yes
121-13	99.84	1.00360	0.99500	Yes
121-14	99.91	1.00393	0.99566	Yes
121-15	99.86	1.00447	0.99690	Yes
121-16	*	*	*	*
121-17	99.89	1.00364	0.99710	Yes
121-18	99.85	1.00230	0.99826	Yes
121-19	99.95	1.00482	0.99725	Yes
121-20	99.87	1.00491	0.99582	Yes
121-21	99.89	1.00405	0.99581	Yes
121-22	99.86	1.00510	0.99595	Yes
121-23	99.88	1.00506	0.99496	Yes

Acceptance Criteria: **High power maps - maximum power tilt: 1.02; minimum power tilt: 0.98**
Low power maps - maximum power tilt: 1.04; minimum power tilt: 0.96

* Flux maps 121-04, 121-05, and 121-16 were not full core flux maps. As a result, they do not constitute a valid measurement of the indicated parameter.

Table 4

Core Reactivity Balance Data

Unit 1 Cycle 21 Boron Letdown Curve

Date	Burnup (MWD/MTU)	Delta Reactivity (pcm)	Acceptable
November 25, 2006	365.66	-151.2	Yes
December 2, 2006	629.55	-45.4	Yes
December 9, 2006	894.82	98.7	Yes
December 12, 2006	1,008.99	11.2	Yes
December 18, 2006	1,238.04	77.4	Yes
January 16, 2007	2,331.74	40.0	Yes
February 13, 2007	3,388.69	83.8	Yes
March 13, 2007	4,446.80	114.5	Yes
April 17, 2007	5,767.02	70.9	Yes
May 15, 2007	6,826.59	64.3	Yes
June 12, 2007	7,880.74	106.6	Yes
July 17, 2007	9,202.00	47.4	Yes
August 14, 2007	10,259.90	17.5	Yes
September 11, 2007	11,255.30	122.4	Yes
October 16, 2007	12,577.30	121.3	Yes
November 13, 2007	13,638.00	68.2	Yes
December 11, 2007	14,694.50	17.8	Yes

Acceptance Criteria: ± 1000 pcm

Table 5

Low Power Physics Test Data (BOL, HZP): ITC

Measured ITC (pcm/°F)	Predicted ITC (pcm/°F)	ITC Error (M-P) (pcm/°F)	Acceptable
-2.48	-1.08	-1.41	Yes

Acceptance Criteria: ITC error within ± 2 pcm/°F

Table 6

Low Power Physics Test Data (BOL, HZP): Total Control Bank Worth

	Measured Worth (pcm)	Predicted Worth (pcm)	Delta Worth (M-P) (pcm)	Worth %Error $\frac{(M-P)x100\%}{P}$	Acceptable
Total Measured Worth	6955	7033	-78	-1.11%	Yes

Acceptance Criteria: Total Measured Worth % error within ±10%

Attachment 2 to AEP:NRC:8132

MOST NEGATIVE END OF LIFE MODERATOR TEMPERATURE COEFFICIENT LIMIT REPORT FOR DONALD C. COOK NUCLEAR PLANT UNIT 1, CYCLE 21

Most Negative End of Life Moderator Temperature Coefficient Limit Report for Donald C. Cook Unit 1, Cycle 21

To facilitate the review of this information, a list of acronyms used in this attachment is provided.

°F	degrees Fahrenheit
Δ	delta
%	percent
AFD	axial flux difference
ARO	all rods out
BOL	beginning of life
C_B	Reactor Coolant System boron concentration
CNP	Donald C. Cook Nuclear Plant
COLR	Core Operating Limits Report
EOL	end of life
HFP	hot full power
HZP	hot zero power
ITC	isothermal temperature coefficient
M	measured
MTC	moderator temperature coefficient
MTU	metric tons of uranium
MWD	megawatt-day
pcm	percent-millirho
ppm	parts per million
P	predicted
RCS	Reactor Coolant System
RTP	reactor thermal power

PURPOSE:

The purpose of this document is to present cycle-specific best estimate data for use in confirming the most negative EOL MTC limit in Technical Specification 3.1.3. This document also summarizes the methodology used for determining if a HFP 300 ppm MTC measurement is required.

PRECAUTIONS AND LIMITATIONS:

The EOL MTC exemption data presented in this document apply to CNP Unit 1 Cycle 21 only and may not be used for other operating cycles.

The following reference is applicable to this document:

WCAP-13749-P-A, "Safety Evaluation Supporting the Conditional Exemption of the Most Negative EOL Moderator Temperature Coefficient Measurement," 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 C_B and incore flux map surveillances 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 Tables 3 and 4, and Figure 1. This methodology is also described in the referenced document. If all core performance benchmark criteria are met and the Revised Predicted MTC is less negative than COLR Limit 2.2.2.b, then a measurement is not required.

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 Difference	± 1000 pcm
BOL HZP ITC	± 2 pcm/°F
Individual Control Bank Worth	NA*
Total Control Bank Worth	± 10 %

* Not required when "The Spatially Corrected Inverse Count Rate (SCICR) Method for Subcritical Reactivity Measurement" has been performed; see letter from J. D. St. John, Westinghouse Electric Company, to M. L. Bellville, American Electric Power Nuclear Generation Group, "NRC Staff Interpretation of WCAP-16260-P-A," NF-AE-06-72, dated May 30, 2006.

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 Revised Predicted Near-EOL 300 ppm MTC

Unit: 1, Cycle 21 **Date:** 12/26/2007 **Time:** 6:27

Reference for Cycle-Specific MTC Data:

CNP, Unit 1 Cycle 21, COLR

Part A. Predicted MTC

A.1	Cycle Average Burnup corresponding to the HFP ARO equilibrium xenon C_B of 300 ppm.	15258	MWD/MTU
A.2	Predicted HFP ARO MTC corresponding to burnup (A.1)	-20.83	pcm/°F

Part B. AFD Correction

B.1	Burnup of most recent HFP, equilibrium conditions incore flux map	14657.9	MWD/MTU
B.2	Measured HFP AFD at burnup (B.1) Reference incore flux map: ID: 121-23 Date: 12/10/07	-2.38	% AFD
B.3	Predicted HFP AFD at burnup (B.1)	-2.23	% 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)}	-0.01	pcm/°F

Part C. Revised Prediction

C.1	Revised Prediction (A.2 + B.5 – 3 pcm/°F)	-23.84	pcm/°F
C.2	Surveillance Limit (COLR 2.2.2.b)	-38.4	pcm/°F

If C.1 is less negative than C.2, then the HFP 300 ppm MTC measurement is not required per Technical Specification Surveillance Requirement 3.1.3.2.

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 6:27 on 12/26/2007
- Burnup at 300 ppm: 15258 MWD/MTU **(A.1)**
- Predicted MTC: -20.83 pcm/°F **(A.2)**

Data from Last Flux Map:

- Flux Map Number: 121-23 **(B.2)**
- Reactor Power (RP): 99.88% RTP
- Burnup: 14657.9 MWD/MTU **(B.1)**
- Measured Axial Flux Difference (MAFD): -2.38% **(B.2)**
  MAFD = Measured Axial Offset * RP / 100%
  = -2.385% * 99.88% / 100%
  = -2.38%

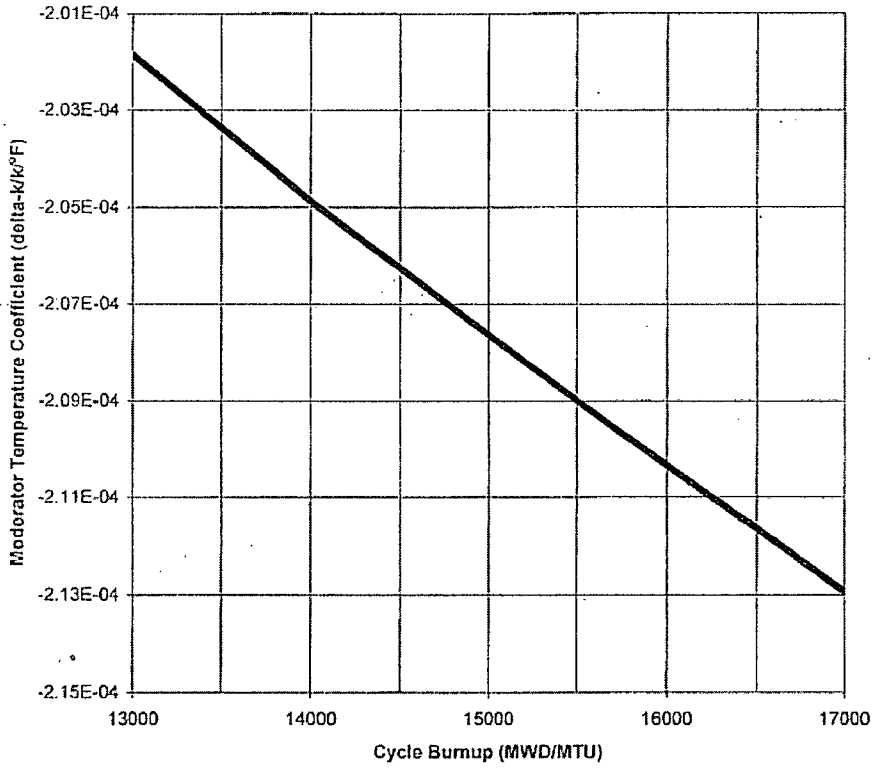
- Predicted Axial Flux Difference (PAFD): -2.23% **(B.3)**
  PAFD = Predicted Axial Offset * RP / 100%
  = -2.23% * 99.88% / 100%
  = -2.23%

  Δ AFD = (MAFD-PAFD)
  = (-2.38% - -2.23%)
  = -0.15%

Determination of the Revised Predicted MTC
AFD Sensitivity: 0.05 pcm/°F/ %ΔAFD **(B.4)**
AFD Correction: -0.01 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 (-0.15% * 0.05 pcm/°F/ %ΔAFD)
0 pcm/°F or -0.01 pcm/°F
∴-0.01 pcm/°F

Revised Predicted MTC = Predicted MTC + AFD Correction -3 pcm/°F
= -20.83 pcm/°F + -0.01 pcm/°F -3 pcm/°F
= -23.84 pcm/°F **(C.1)**

Figure 1
Unit 1 Cycle 21 Predicted HFP ARO 300 ppm MTC Versus Burnup



Burnup (MWD/MTU)	MTC (Δk/k/°F)
13000	-2.0185E-4
14000	-2.0487E-4
15000	-2.0764E-4
16000	-2.1035E-4
17000	-2.1293E-4