INDIANA MICHIGAN POWER
A unit of American Electric Power

Indiana Michigan Power
Cook Nuclear Plant
One Cook Place
Bridgman, MI 49106
AEP.com

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AEP:NRC:6132

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

Donald C. Cook Nuclear Plant Unit 2
Unit 2 Cycle 15 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 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 elimination 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 Elimination of the Most Negative EOL Moderator Temperature Coefficient Measurement,* have been met; and,

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

The information is attached. This transmittal is the first of the three submittals for Unit 2. There are no new commitments made in this submittal.

A001

Should you have any questions, please contact Mr. Michael K. Scarpello, Regulatory Affairs Supervisor, at (269) 466-2649.

Sincerely,

Joseph N. Jensen
Site Vice President

KS/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 2, Cycle 15

c: J. L. Caldwell, NRC Region III
K. D. Curry, Ft. Wayne AEP, w/o attachments
J. T. King, MPSC
MDEQ – WHMD/RPMWS
NRC Resident Inspector
P. S. Tam, NRC Washington, DC

Attachment 1 to AEP:NRC:6132

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 2 Cycle 15 core characteristics with the requirements for use of the Conditional Exemption of the Most Negative EOL MTC 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 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 2, Cycle 15, core design and relevant analyses. Also, the Unit 2, Cycle 15, 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 15 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): 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 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

Assembly Power Determination

Map	Date	Power (%)	(Maximum Magnitude of Relative Error)				
			Measured Power	Predicted Power	|Predicted - Measured|	10% of Predicted	Acceptable
215-01	11/10/2004	26.76	1.189	1.280	0.091	0.128	YES
215-02	11/11/2004	44.88	1.123	1.197	0.074	0.120	YES
215-03	11/13/2004	85.88	1.132	1.197	0.065	0.120	YES
215-04	11/16/2004	99.84	1.145	1.202	0.057	0.120	YES
215-05	Map was discarded as the repeat data for Detector A and Detector F did not satisfy the processing criteria.						
215-06	12/13/2004	99.95	0.477	0.455	0.022	0.046	YES
215-07	1/3/2005	99.89	0.988	1.032	0.044	0.103	YES
215-08	1/10/2005	99.82	0.373	0.356	0.017	0.036	YES
215-09	1/17/2005	99.72	0.336	0.322	0.014	0.032	YES
215-10	1/26/2005	99.83	0.472	0.448	0.024	0.045	YES
215-11	2/14/2005	99.82	0.374	0.355	0.019	0.036	YES
215-12	3/15/2005	100.04	0.372	0.354	0.018	0.035	YES
215-13	4/11/2005	99.81	0.373	0.352	0.021	0.035	YES
215-14	5/9/2005	99.88	0.995	1.039	0.044	0.104	YES
215-15	6/6/2005	99.89	1.004	1.041	0.037	0.104	YES
215-16	7/11/2005	99.89	0.390	0.372	0.018	0.037	YES
215-17	8/8/2005	99.91	0.398	0.378	0.020	0.038	YES
215-18	9/6/2005	99.80	1.108	1.052	0.056	0.105	YES
215-19	10/10/2005	99.97	1.120	1.056	0.064	0.106	YES
215-20	11/7/2005	99.93	0.395	0.370	0.025	0.037	YES
215-21	12/5/2005	99.94	0.405	0.377	0.028	0.038	YES

Acceptance Criteria: ± 0.1 or 10%.

Table 3

Flux Map Data: Core Tilt Criteria

Top Half Incore Quadrant Power Tilt

Map #	Power (%)	Maximum Tilt	Minimum Tilt	Acceptable
215-01	26.76	1.00347	0.99430	Yes
215-02	44.88	1.00799	0.99566	Yes
215-03	85.88	1.00714	0.99414	Yes
215-04	99.84	1.00614	0.99275	Yes
215-05	Map was discarded as the repeat data for Detector A and Detector F did not satisfy the processing criteria.			
215-06	99.95	1.00590	0.99213	Yes
215-07	99.89	1.00503	0.99196	Yes
215-08	99.82	1.00632	0.99248	Yes
215-09	99.72	1.00511	0.99212	Yes
215-10	99.83	1.00581	0.99290	Yes
215-11	99.82	1.00638	0.99083	Yes
215-12	100.04	1.00923	0.98839	Yes
215-13	99.81	1.00549	0.99370	Yes
215-14	99.88	1.00595	0.99393	Yes
215-15	99.89	1.00412	0.99434	Yes
215-16	99.89	1.00245	0.99752	Yes
215-17	99.91	1.00333	0.99633	Yes
215-18	99.80	1.00172	0.99637	Yes
215-19	99.97	1.00133	0.99831	Yes
215-20	99.93	1.00287	0.99645	Yes
215-21	99.94	1.00361	0.99422	Yes

Bottom Half Incore Quadrant Power Tilt

Map #	Power (%)	Maximum Tilt	Minimum Tilt	Acceptable
215-01	26.76	1.00667	0.99430	Yes
215-02	44.88	1.00528	0.99331	Yes
215-03	85.88	1.00622	0.99204	Yes
215-04	99.84	1.00620	0.99146	Yes
215-05	Map was discarded as the repeat data for Detector A and Detector F did not satisfy the processing criteria.			
215-06	99.95	1.00484	0.99315	Yes
215-07	99.89	1.00322	0.99657	Yes
215-08	99.82	1.00609	0.99365	Yes
215-09	99.72	1.00601	0.99329	Yes
215-10	99.83	1.00780	0.99327	Yes
215-11	99.82	1.00744	0.99549	Yes
215-12	100.04	1.00386	0.99599	Yes
215-13	99.81	1.00207	0.99677	Yes
215-14	99.88	1.00320	0.99676	Yes
215-15	99.89	1.00373	0.99675	Yes
215-16	99.89	1.00327	0.99563	Yes
215-17	99.91	1.00492	0.99746	Yes
215-18	99.80	1.00475	0.99697	Yes
215-19	99.97	1.00433	0.99520	Yes
215-20	99.93	1.00483	0.99615	Yes
215-21	99.94	1.00396	0.99578	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

Table 4

Core Reactivity Balance Data

Unit 2 Cycle 15 Boron Letdown Curve

Date	Burnup (MWD/MTU)	Delta Reactivity (pcm)	Acceptable
18-Nov-04	265.6	-400.1	Yes
21-Nov-04	396.2	-318.8	Yes
5-Dec-04	698.7	-125.1	Yes
9-Dec-04	871.1	-54.1	Yes
12-Dec-04	1,000.6	-0.8	Yes
16-Dec-04	1,171.9	34.0	Yes
19-Dec-04	1,301.5	62.7	Yes
22-Dec-04	1,429.7	92.1	Yes
5-Jan-05	2,031.2	151.9	Yes
19-Jan-05	2,632.1	228.4	Yes
16-Feb-05	3,750.7	297.2	Yes
15-Mar-05	4,923.7	434.2	Yes
13-Apr-05	6,166.2	537.4	Yes
10-May-05	7,328.0	644.0	Yes
7-Jun-05	8,524.3	706.7	Yes
12-Jul-05	10,028.0	738.0	Yes
9-Aug-05	11,230.6	786.0	Yes
6-Sep-05	12,432.6	749.9	Yes
11-Oct-05	13851.6	449.6	Yes
6-Nov-05	14969.9	426.6	Yes
6-Dec-05	16092.9	173.3	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
-1.811	-0.174	-1.637	Y

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

Table 6

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

	Measured Worth (pcm)	Predicted Worth (pcm)	Delta Worth (M-P) (pcm)	Worth %Error $\frac{(M-P)x100\%}{P}$	Acceptable
Shutdown Bank A	259.3	258.4	0.9	0.3	Y
Shutdown Bank B	758.6	769.3	-10.7	-1.4	Y
Shutdown Bank C	408.6	408.6	0.0	0.0	Y
Shutdown Bank D	417.2	410.1	7.1	1.7	Y
Control Bank A	415.0	398.3	16.7	4.2	Y
Control Bank B	599.0	603.1	-4.1	-0.7	Y
Control Bank C	759.8	751.6	8.2	1.1	Y
Control Bank D	1220.7	1182.1	38.6	3.3	Y
Total Measured Worth	4838.2	4781.5	56.7	1.2	Y

Acceptance Criteria: Individual bank rod worth % error within ±15%
or Delta Worth within ±100 pcm.
Acceptance Criteria: Total Measured Worth % error within ±10%

Attachment 2 to AEP:NRC:6132

MOST NEGATIVE END OF LIFE MODERATOR TEMPERATURE COEFFICIENT LIMIT REPORT FOR DONALD C. COOK NUCLEAR PLANT UNIT 2, CYCLE 15

Most Negative End of Life Moderator Temperature Coefficient Limit Report for Donald C. Cook Unit 2, Cycle 15

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

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	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 end of life 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 elimination data presented in this document apply to CNP Unit 2 Cycle 15 only and may not be used for other operating cycles.

The following reference is applicable to this document:

1. 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 C_B and incore 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 2.2.2b, 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	± 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 Revised Predicted Near-EOL 300 ppm MTC

Unit: 2, Cycle 15 **Date:** 01/01/2006 **Time:** 16:23

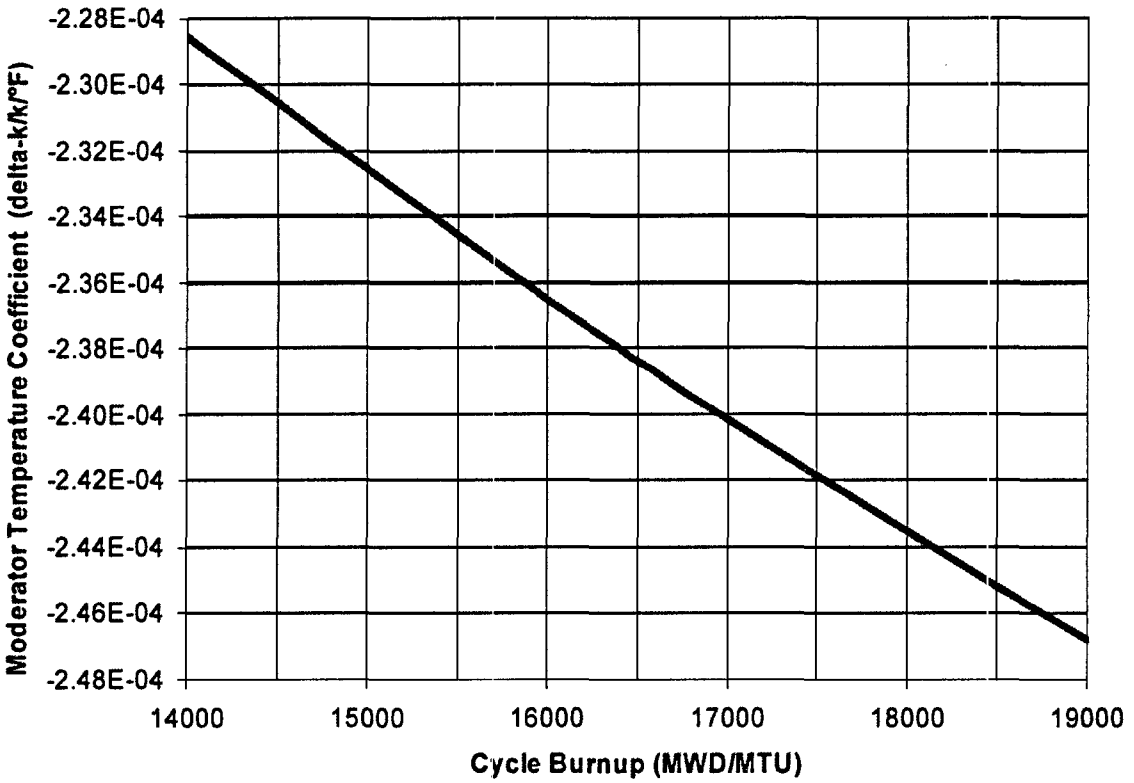
Reference for Cycle-Specific MTC Data:

CNP, Unit 2 Cycle 15, COLR

Part A. Predicted MTC			
A.1	Cycle Average Burnup corresponding to the HFP ARO equilibrium xenon C_B of 300 ppm.	17217.0	MWD/MTU
A.2	Predicted HFP ARO MTC corresponding to burnup (A.1)	-24.09	pcm/°F
Part B. AFD Correction			
B.1	Burnup of most recent HFP, equilibrium conditions incore flux map	16053.4	MWD/MTU
B.2	Measured HFP AFD at burnup (B.1) Reference incore flux map: ID: 215-21 Date: 12/05/05	-2.168	% AFD
B.3	Predicted HFP AFD at burnup (B.1)	-1.18	% 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)}	-0.049	pcm/°F
Part C. Revised Prediction			
C.1	Revised Prediction (A.2 + B.5 – 3)	-27.14	pcm/°F
C.2	Surveillance Limit (COLR 2.2.2b)	-32.0	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.

Figure 1
Unit 2 Cycle 15 Predicted HFP ARO 300 ppm MTC Versus Burnup



Burnup (MWD/MTU)	MTC (Δk/k/°F)
14000	-2.2855E-4
15916	-2.3615E-4
16916	-2.3984E-4
17916	-2.4325E-4
19000	-2.4679E-4

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 1623 on 01/01/06
- Burnup at 300 ppm: 17217 MWD/MTU **(A.1)**
- Predicted MTC: -24.09 pcm/°F **(A.2)**

Data from Last Flux Map:

- Flux Map Number: 215-21 **(B.2)**
- Reactor Power (RP): 99.94% RTP
- Burnup: 16053.4 MWD/MTU **(B.1)**
- Measured Axial Flux Difference (MAFD): -2.168% **(B.2)**

MAFD = Measured Axial Offset * RP / 100%
= -2.169% * 99.94% / 100%
= -2.168%

- Predicted Axial Flux Difference (PAFD): -1.18% **(B.3)**

Δ AFD = (MAFD-PAFD)
= (-2.168% + 1.18%)
= -0.988%

Determination of the Revised Predicted MTC
AFD Sensitivity: 0.05 pcm/°F/ %ΔAFD
AFD Correction: -0.049 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 (-0.988% * 0.05 pcm/°F/ %ΔAFD)
0 pcm/°F or -0.049 pcm/°F
∴-0.049 pcm/°F

Revised Predicted MTC = Predicted MTC + AFD Correction - 3 pcm/°F
= -24.09/°F - 0.049 pcm/°F – 3 pcm/°F
= -27.14/°F **(C.1)**