NMC
Committed to Nuclear Excellence

Kewaunee Nuclear Power Plant
Operated by Nuclear Management Company, LLC

March 10, 2004

NRC-04-037
TS 6.9.a.1

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

KEWAUNEE NUCLEAR POWER PLANT
DOCKET 50-305
LICENSE No. DPR-43

CYCLE 26 STARTUP REPORT

In accordance with the requirements of Kewaunee Nuclear Power Plant (KNPP) Technical Specification (TS) 6.9.a.1, Nuclear Management Company (NMC) is required to submit a summary report of plant startup and power escalation testing within 90 days following resumption of power operation. The KNPP TS requires this report whenever certain listed activities occur. The two activities that occurred this last cycle are the use of fuel assemblies from a different manufacturer and a measurement uncertainty recapture (MUR) power uprate of 1.4%. Enclosed is the KNPP Cycle 26 Startup Report.

Contrary to the above requirement, this report is submitted past the required 90 days. This item has been reviewed and entered into the Corrective Action Program. Appropriate measures have been taken to resolve the issue.

Thomas Coutu

Thomas Coutu
Site Vice-President, Kewaunee Plant
Nuclear Management Company, LLC

Enclosures (2)

cc: Administrator, Region III, USNRC
Project Manager, Kewaunee, USNRC
Senior Resident Inspector, Kewaunee, USNRC
Public Service Commission of Wisconsin

IE26

ENCLOSURE 1
FUEL TRANSITION REPORT

INTRODUCTION

During the refueling outage preceding Cycle 26 operation, Nuclear Management Company, LLC (NMC) began a transition from Framatome ANP nuclear fuel to Westinghouse 422V+ nuclear fuel. This transition was approved by an NRC Safety Evaluation dated April 4, 2003. Additionally, during this refueling outage, NMC increased the KNPP RCS temperature band from 547°F to 562°F (0 to 100% power) to 547 °F to 572 °F, 0 to 100%.

This report presents the results of the physics tests performed during startup of the Kewaunee Nuclear Power Plant (KNPP) Cycle 26. The core design and reload safety evaluation were performed by Westinghouse using approved methods. The results of the physics tests were compared to NMC analytical results to confirm calculated safety margins. No corrective actions were required.

FUEL ASSEMBLIES

The KNPP reactor core consists of 121 fuel assemblies of 14 x 14 design:

- Forty-four (44) new Westinghouse 422V+ fuel assemblies containing UO_2 rods. Twenty-eight (28) are enriched to 4.6 weight percent U_{235} , and sixteen (16) are enriched to 4.95 weight percent U_{235} .

- Four (4) Westinghouse 422V+ fuel assemblies containing UO_2 rods enriched to 3.3 weight percent U_{235} .

- Seventy-three (73) partially depleted FRA-ANP heavy assemblies.

RCCA BANK MEASUREMENTS

During Cycle 26 startup the worth of all control rods were measured using the reactivity computer using the Westinghouse Dynamic Rod Worth methodology. The table below provides a summary of the RCCA Worth data:

RCCA Bank	Measured Worth (PCM)	Predicted Worth (PCM)	Difference (PCM)	Percent Difference
A	869.9	916.2	-19.3	-2.1
B	640.0	611.0	29.0	4.7
C	866.4	842.7	23.7	2.8
D	866.4	864.9	1.5	0.2
SA	570.2	567.5	2.7	0.5
SB	573.5	570.5	3.0	0.5
TOTAL	**4413.4**	**4372.8**	**40.6**	**0.9**

SHUTDOWN MARGIN EVALUATION

Prior to power escalation a shutdown margin evaluation was made to verify the existence of core shutdown capability. The minimum shutdown margins at beginning and at end of cycle are presented in the Table below:

RCCA Bank Worths (PCM)	BOC	EOC
N	5500	6280
N-1 (Worst Stuck Rod)	4920	5620
Less 8.5 Percent	420	480
Sub Total	4500	5140
Total Requirements (Including Uncertainties)	2070	3690
Shutdown Margin	**2430**	**1450**
Required Shutdown Margin	**1430**	**1430**

An 8.5 percent uncertainty in the calculation of total rod worth is accounted for in the shutdown margin analyses. Since the measured total rod worth result fell within the acceptable range compared to the predicted value, the analysis was conservative and no additional evaluations were required.

BORON ENDPOINTS AND BORON WORTH MEASUREMENTS

1. Boron Endpoints

Criticality was achieved by dilution with Bank D near ARO. Boron concentration was allowed to stabilize. The critical boron concentration for these core configurations was then determined by boron endpoint measurement. The results indicated a difference of -62 PPM for the ARO condition. The acceptance criterion on the all rods out boron endpoint is ±100 PPM; thus, the boron endpoint comparisons are considered acceptable. The table below summarizes the RCCA Bank Endpoint measurements:

RCCA Bank Configuration	Measured Endpoint (PPM)	Predicted Endpoint (PPM)	Difference (PPM)
All Rods Out	2350	2288	-62

2. Differential Boron Worth

The differential boron worth was not calculated for Cycle 26. The reference bank was not measured by dilution, due to Dynamic Rod Worth Measurements being used to determine rod worths. There is no requirement or acceptance criterion for determination of the Differential Boron Worth. The boron endpoint measurement described above is adequate to determine if the differential boron worth assumption in the model is accurate.

ISOTHERMAL TEMPERATURE COEFFICIENT

The measurement of the isothermal temperature coefficient was accomplished by monitoring reactivity while cooling down and heating up the reactor by manual control of the steam dump valves. The temperature change, reactivity change, and the temperature coefficient were obtained from the reactivity computer temperature coefficient analysis results.

Core conditions at the time of the measurement were Bank D slightly inserted, all other RCCA banks full out, with a boron concentration of 2340 PPM. These conditions approximate the HZP, all rods out core condition, which yields the most conservative (least negative) isothermal temperature coefficient measurement. The review criterion of ±3 PCM/°F was met. The Isothermal Temperature Coefficient data is presented below:

Cooldown

T_{ave}	-	544.2 °F
Bank D	-	188 Steps
Boron Concentration	-	2340 PPM

Measured ITC (PCM/°F)	Predicted ITC (PCM/°F)	Difference (PCM/°F)
-0.17	-0.69	0.52

Heat Up

T_{ave}	-	544.3 °F
Bank D	-	188 Steps
Boron Concentration	-	2340 PPM

Measured ITC (PCM/°F)	Predicted ITC (PCM/°F)	Difference (PCM/°F)
-1.11	-0.69	-0.42

POWER DISTRIBUTION

1. Summary of Power Distribution Criteria

Power distribution predictions are verified through data recorded using the incore detector system and processed through the *INCORE* computer code. The computer code calculates F_Q^{EQ} and $F_{\Delta H}^{N}$, which are limited by technical specifications. These parameters are defined as the acceptance criteria on a flux map.

The review criterion for measurement is that the percent differences of the normalized reaction rate integrals of symmetric thimbles do not exceed 10 percent at low power physics test conditions and 6 percent at equilibrium conditions.

The review criterion for the prediction is that the standard deviation of the percent differences between measured and predicted reaction rate integrals does not exceed 5 percent.

The review criteria for the INCORE calculated quadrant powers are that the quadrant tilt is less than 4 percent at low power physics test conditions and less than 2 percent at equilibrium conditions.

A summary of the review criteria is presented in Table 1.

2. Power Distribution Measurements

Comparisons of measured to predicted power distributions for the flux maps are exhibited in the Tables below.

- Table 2 contains the startup and flux map chronology.
- Table 3 identifies flux map peak $F_{\Delta H}^{N}$ and minimum margin F_{Q}^{EQ} for FRA-ANP heavy fuel.
- Table 4 identifies flux map peak $F_{\Delta H}^{N}$ and minimum margin F_{Q}^{EQ} for Westinghouse 422V+ fuel.
- Table 5 identifies flux map peak $F_{\Delta H}^{N}$ and minimum margin F_{Q}^{EQ} for Westinghouse 422V+ fuel Lead Use Assemblies.

These tables address acceptance criteria by verifying that technical specification limits are not exceeded. The Cycle 26 startup flux maps met all acceptance criteria.

Table 1

Verification of Review Criteria

Flux Map	(a) Maximum Percent Difference	(b) Standard Deviation	(c) Percent Max. Quadrant Tilt
2601	2.9	2.833	0.35
2602	2.7	3.452	0.42
2603	2.4	2.880	0.57
2604	2.5	3.262	0.56
2605	2.8	2.927	0.48
2606	2.7	2.986	0.65

(a) Maximum Percent Difference between symmetric thimbles for measured reaction rate integrals. From *INCORE* edit C-DRR, maximum positive value. Review criterion is 10 percent at low power. Review criterion is 6 percent at equilibrium power.

(b) Standard Deviation of the percent difference between measured and predicted reaction rate integrals. From *INCORE* edit C-DRRSY. Review criterion is 5 percent.

(c) Percent Maximum Quadrant Tilt from normalized calculated quadrant powers. From *INCORE* edit E-SUM, maximum positive value. Review criteria are 4 percent at low power and 2 percent at equilibrium power.

Table 2

Flux Map Chronology and Reactor Characteristics

Map	Date	Percent Power	Xenon	Boron PPM	D Rods Steps	Exposure MDW/MTU
2601	5/12/03	29.5	EQ	2251	160	24
2602	5/13/03	71.2	EQ	1928	175	55
2603	5/15/03	84.2	EQ	1784	205	105
2604	5/16/03	90.0	EQ	1784	203	124
2605	5/19/03	99.7	EQ	1694	211	201
2606	5/23/03	100.0	EQ	1655	226	339

Table 3

Verification of Acceptance Criteria for FRA-ANP Heavy Fuel

Flux Map	Core Location	FDHN	Limit
2601	H-6 (JD)	1.4777	1.914
2602	F-8 (EK)	1.4892	1.716
2603	F-8 (EK)	1.4727	1.662
2604	F-8 (EK)	1.4708	1.627
2605	F-8 (EK)	1.4719	1.580
2606	F-8 (EK)	1.4690	1.580

Flux Map	Core Location	FQEQ	Limit
2601	G-11 (XX), 32	2.1650	4.376
2602	G-11 (XX), 33	2.0081	3.300
2603	G-11 (XX), 24	1.9163	2.791
2604	G-11 (XX), 32	1.9390	2.611
2605	C-7 (XX), 30	1.8974	2.358
2606	G-11 (XX), 33	1.8869	2.350

Table 4

Verification of Acceptance Criteria for Westinghouse 422V+ Fuel

Flux Map	Core Location	FDHN	Limit
2601	F-3 (LK)	1.6395	2.060
2602	K-6 (KE)	1.6251	1.847
2603	K-6 (KC)	1.6476	1.788
2604	K-6 (KC)	1.6425	1.751
2605	F-3 (KL)	1.6411	1.700
2606	F-3 (KL)	1.6376	1.700
Flux Map	**Core Location**	**FQEQ**	**Limit**
2601	C-8 (XX), 33	2.4733	4.656
2602	K-6 (XX), 30	2.3173	3.511
2603	K-6 (XX), 27	2.2397	2.969
2604	K-6 (XX), 30	2.2065	2.778
2605	C-6 (XX), 34	2.1674	2.509
2606	C-6 (XX), 34	2.1477	2.501

Table 5

Verification of Acceptance Criteria for Westinghouse 422V+ Fuel Lead Use Assemblies

Flux Map	Core Location	FDHN	Limit
2601	G-13 (AL)	0.6555	1.878
2602	G-13 (AL)	0.6730	1.684
2603	M-7 (CA)	0.6863	1.630
2604	M-7 (CA)	0.6853	1.596
2605	M-7 (CA)	0.6884	1.550
2606	M-7 (CA)	0.6920	1.550

Flux Map	Core Location	FQEQ	Limit
2601	M-7 (XX), 31	0.9852	4.042
2602	M-7 (CA), 30	0.9490	3.048
2603	M-7 (CA), 25	0.9257	2.578
2604	M-7 (XX), 32	0.9258	2.412
2605	M-7 (XX), 34	0.9113	2.178
2606	M-7 (XX), 35	0.9138	2.170

ENCLOSURE 2
POWER UPRATE REPORT

UPRATE ACTIVITIES

Subsequent to the plant startup for Cycle 26, NMC received approval to increase the rated power of the KNPP to 1673 MWt, a 1.4% increase.

As part of the R26 Refueling outage, the 0% - 100% power Tave operating band was changed from 547°F - 562°F to 547°F - 572°F to achieve an increase in full load main steam pressure to facilitate a proposed on line 7.4% power uprate planned following the refueling. The 7.4% uprate will occur in two parts. The 1.4% measurement uncertainty recapture is already in effect and the 6% uprate should occur before the next refueling outage upon staff approval. The increased steam pressure reduces the main steam volumetric flow at uprate conditions to within the capability of HP Turbine steam path to maintain a minimum acceptable throttling margin in the control valves.

The applicable portions of the testing program identified in the USAR applicable to the increase in Tave operating band are described in USAR section 13.3, Initial Testing of the Operating Reactor (Phase III). USAR Section 13.3 states the testing is to acquire data for the proper calibration of setpoints and to ensure that operation is within license requirements. USAR Section 13.3.4, Post-Startup Surveillance and Testing Requirements, states that the startup surveillance and testing requirements were designed to provide assurance that essential systems, which included equipment components and instrument channels, are capable of performing in accordance with their original design criteria. Specific Phase III tests include relevant to the change in Tave operating band are:

- Automatic Control System Checkout
- Turbine Generator Startup Tests

To facilitate the 10°F increase in the 100% power Tave, instrumentation for Tref, Pressurizer Level Control, Rod Control, Steam Dump Control, Overpower ΔT, and Over Temperature ΔT were rescaled/calibrated consistent with the new Tave operating band using normal plant procedures for calibrating and testing the instrumentation. In addition, Plant Process Computer programs and alarm setpoints were updated to incorporate the change in the Tave operating band. To support the subsequent on line implementation of the planned 7.4% power uprate, the main feedwater regulating valve trim was changed out to accommodate the increased feedwater flow associated with the planned 7.4% power uprate and the turbine generator electronic overspeed settings were reduced to prevent exceeding the design overspeed at the 7.4% uprated power. In addition, selected turbine casing and coupling bolting were changed out to accommodate the increased stresses and torque associated with the 7.4% uprate.

Prior to startup following the R26 refueling, plant procedures and documentation were updated to reflect the change in the Tave operating band and the reduced turbine electronic overspeed settings.

The applicable portions of the USAR described tests were performed during the initial startup following the refueling consistent with the normal low power physics testing and power ascension testing. The Turbine Generator Startup Tests were performed as part of the normal plant startup which tests the turbine overspeed system. The Automatic Control System Checkout was performed by monitoring the response and indications of the control and protection instrumentation recalibrated to the new Tave operating band as well as the response of the main feedwater regulating valves. The response and indications of these systems compared quite favorably with the predicted values and determined to be satisfactory. The response of the control and protection instrumentation and the main feedwater regulating valves indicate the plant will continue to satisfactorily respond to original designed plant transients. In addition, during the initial power increase, walkdowns of the accessible areas of systems impacted by the increase in Tave were conducted to identify any abnormal changes in the piping supports and vibration. No abnormal changes were identified by the walkdowns.

1.4% MUR Power Uprate

KNPP performed a 1.4% Measurement Uncertainty Recapture (MUR), increasing licensed core power from 1650 MWt to 1673 MWt. In order to perform the 1.4% MUR uprate, KNPP installed an AMAG/CROSSFLOW ultrasonic flow measurement device (UFMD) capable of measuring feedwater flow and feedwater temperature to develop correction factors for the feedwater flow channels on each venturi and the feedwater temperature used in the RTO calculations. With the UFMD in service, the power measurement uncertainty is reduced from the 2% associated with the feedwater flow venturis to 0.6%. This uprate resulted in a nominal 7.5 MWe increase in electrical output.

The applicable portions of the testing program identified in the USAR applicable to the 1.4% MUR uprate are described in USAR section 13.3, Initial Testing of the Operating Reactor (Phase III). USAR Section 13.3 states the testing is to acquire data for the proper calibration of setpoints and to ensure that operation is within license requirements. USAR Section 13.3.4, Post- Startup Surveillance and Testing Requirements, states that the startup surveillance and testing requirements were designed to provide assurance that essential systems, which include equipment components and instrument channels, are capable of performing in accordance with their original design criteria. Specific Phase III tests include relevant to the 1.4% MUR uprate are:

- Power Range Nuclear Instrumentation (NI) Calibration
- Reactor Coolant System (RCS) Loop Delta Temperature (ΔT) Instrumentation Calibration

License Amendment 168 contained the following commitments associated with implementation of the 1.4% MUR uprate:

1. KNPP will complete revisions to affected documents (i.e., procedures) and provide appropriate training to the necessary plant staff for changes associated with the installation of the Crossflow UFMD and the implementation of the new rated power.
2. The KNPP will ensure the plant specific analysis has been completed and that the plant specific uncertainties are equal to or less than those provided to Westinghouse for the calculation of the power measurement uncertainty.
3. KNPP will complete revisions to affected operations procedures and provide appropriate training to operations for the implementation of the new rated power and the administrative restrictions for inoperable Crossflow UFMDs.
4. The KNPP EQ Plan will be updated to include the new containment exclusion areas for the pressurizer, steam generator, and reactor coolant pump vaults.
5. A corrective action request has been initiated to investigate the Reserve Auxiliary Transformer procedural limit. This will be completed prior to the MUR power uprate implementation.
6. Modifications associated with the MUR power uprate will be completed prior to implementation. This includes the installation of the Crossflow UFMDs and implementation of the PPCS and control room alarm functions.
7. Rescaling and setting changes of the protection system will be completed as necessary.

KNPP developed a 1.4% MUR Implementation Plan to control the activities leading up to and including implementation of License Amendment 168 and the escalation of reactor power to the new licensed power level. Commitments 1 – 6 were documented as complete as prerequisites in the MUR Implementation Plan. Commitment 7 was completed during the implementation of Licensed Amendment 168.

Commitments 2 and 6 were completed as part of the modification installing the UFMD. Also included, as part of the modification installing the UFMD was comparative RTO calculations with and without using the UFMD correction factors. The differences between the comparative calculations were within the expected uncertainty differences between using the venturis and the UFMD.

USAR and technical specification testing associated with the power range nuclear instruments is a calibration based on a secondary heat balance. Prior to increasing reactor power, the power range nuclear instrument was calibrated using a secondary heat balance based on the new 100% licensed power level. Once reactor power was increased to the new licensed level, the power range nuclear instrument indication was compared to a secondary heat balance performed at the uprated power. The power range nuclear instrument indications were consistent with the uprated power heat balance, thereby satisfying the testing requirements for the power range nuclear instruments.

Testing of the RCS Loop control and protection ΔT Instrumentation was performed by calibrating and testing the individual loop Over Temperature ΔT (OTΔT) and Over Power ΔT (OPΔT) control and protection instrumentation channels using predicted ΔT values for the uprated power. Following the increase to the uprated power level, the individual loop ΔT indications were consistent with the predicted uprate full power values and no additional adjustments or calibrations were required, thereby satisfying the testing requirements for the RCS Loop ΔT control and protection instrumentation.

In addition to the above testing key, plant parameters for pre and post uprate conditions were monitored and evaluated. The changes in the key plant parameters compared favorably with the predicted changes and were determined to be satisfactory. Pre and post system walkdowns of accessible areas of systems impacted by the uprate were performed to identify any unexpected or abnormal changes resulting from the uprate. No unexpected or abnormal changes were identified.