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Subject: Catawba Nuclear Station, Unit 1
Docket No. 50-413
Unit 1 Cycle 15 Startup Report

Catawba Unit 1 Cycle 15 (C1C15) completed its transition to Westinghouse Robust Fuel Assembly (RFA) with the introduction of the third batch of RFAs into the core design. Additionally, C1C15 incorporates eight lead test assemblies which are Westinghouse Next Generation Fuel (NGF) assemblies. Power escalation testing including first flux map at full power was completed on January 6, 2004.

Section 14.3.4, item (3) of the Catawba Updated Final Safety Analysis Report requires a summary report to be submitted within 90 days following resumption of commercial power operation if the fuel has a different design. Accordingly, the Unit 1 Cycle 15 Startup Report dated January 2004 is attached.

There are no regulatory commitments contained in this document. Any questions concerning this report may be directed to Kay Nicholson at 803.831.3237.

Sincerely,

Dhiaa M. Jamil

Attachments

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IE26

Duke Power Company
Catawba Nuclear Station
Unit 1 Cycle 15

STARTUP REPORT

January 2004

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1.0 INTRODUCTION

C1C15 completes Catawba Unit One's transition to Westinghouse Robust Fuel Assemblies (RFA) with the introduction of its third batch of RFAs. The C1C15 core consists of a feed batch of 69 of these fuel assemblies. The feed batch enrichments are 36 RFAs at 4.32% (w/o U-235) with 6 inch 2.6% (w/o U-235) annular blankets, and 33 F/A's at 4.70% (w/o U-235) with 6 inch 2.6% (w/o U-235) annular blankets.

Additionally, C1C15 incorporates 8 Lead Test Assemblies (LTA). These LTAs are Westinghouse Next Generation Fuel (NGF) assemblies enriched to 4.32% (w/o U-235) with 6 inch 2.6% (w/o U-235) annular blankets.

Burnable absorbers accompanying the feed batch are of two designs: Integral Fuel Burnable Absorber (IFBA) and Wet Annular Burnable Absorber (WABA), both manufactured by Westinghouse.

A total of 16 previously discharged Mark-BW fuel assemblies (8 from 1EOC10 and 8 from 1EOC11) have been reinserted for C1C15.

C1C15 core loading commenced at 1219 on December 2, 2003 and concluded at 1009 on December 4, 2003. Initial criticality for Cycle 15 occurred at 2315 on December 18, 2003. Zero Power Physics Testing was completed at 0600 on December 19, 2003. The unit reached full power at 1900 on January 3, 2004. Power Escalation testing, including first flux map at full power, was completed by 1100 on January 6, 2004.

Table 1 summarizes important characteristics of the Catawba 1 Cycle 15 core design.

TABLE 1
C1C15 CORE DESIGN DATA

1. C1C14 end of cycle burnup: 522.7 EFPD

2. C1C15 design length: 509 –10 / +15 EFPD

Region	Fuel Type	Number of Assemblies	Enrichment, w/o U^{235}	Loading, MTU*	Cycles Burned
11	Mk-BW	16	3.86	7.2803	3
15A	W RFA	12	3.92/2.6*	7.3053	2
15B	W RFA	4	4.47/2.6*		2
16A	W RFA	56	4.33/2.6*	38.3835	1
16B	W RFA	28	4.63/2.6*		1
17A	W RFA	36	4.32/2.6*	35.1665	0
17B	W RFA	33	4.70/2.6*		0
17C	W NGF	8	4.32/2.6*		0
Totals		193		88.1356	

* 2.60% (w/o U-235) enriched annular Uranium blanket, 6 inches top and bottom

2.0 PRECRITICAL TESTING

Precritical testing includes:

- Core Loading
- Preliminary Calibration of Nuclear Instrumentation
- Dilution of Reactor Coolant System to Estimated Critical Boron concentration
- Rod Drop Timing Test

Sections 2.1 through 2.5 describe results of precritical testing for Catawba 1 Cycle 15.

2.1 Total Core Reloading

The Cycle 15 core was loaded under the direction of PT/0/A/4150/22, Total Core Reloading. Plots of Inverse Count Rate Ratio (ICRR) versus number of fuel assemblies loaded were maintained for each applicable Source Range NIS and Boron Dilution Mitigation System (BDMS) channel.

Core loading commenced at 1219 on December 2, 2003 and concluded at 1009 on December 4, 2003. Core loading was verified per PT/0/A/4550/03C, Core Verification, which was completed at 1300 on December 4, 2003.

Figure 1 shows the core loading pattern for Catawba 1 Cycle 15.

2.2 Preliminary NIS Calibration

Periodic test procedure PT/0/A/4600/05E, Preliminary NIS Calibration, is performed before initial criticality for each new fuel cycle. Intermediate Range Reactor Trip and Rod Stop setpoints are adjusted using measured power distribution from the previous fuel cycle and predicted power distribution for the upcoming fuel cycle. Power Range NIS full power currents are similarly adjusted. Intermediate Range (I/R) NIS Rod Stop and Reactor Trip setpoints are checked and revised as necessary for initial power ascension. An added conservatism of 20% is applied procedurally to I/R setpoints.

Table 3 shows the calibration data calculated by PT/0/A/4600/05E. Calculations were performed on November 26, 2003. Calibrations were completed on December 14, 2003.

2.3 Reactor Coolant System Dilution

The reactor coolant system boron concentration was diluted from the refueling boron concentration to the estimated critical boron concentration per PT/0/A/4150/19B, NC System Dilution Following Refueling. ICRR was plotted versus gallons of demineralized water added.

Initial reactor coolant boron concentration was 2,506 ppmB. The Target Boron Concentration for the dilution was calculated to be 1772 ppmB (Minimum Boron Concentration to Maintain Keff < 0.99 with Shutdown Banks Withdrawn + 50 ppmB conservatism). The calculated volume of demineralized water required was 27,673 gallons. This change in boron concentration was expected to decrease ICRR from 1.0 to 0.51.

Reactor coolant system dilution at ~87 GPM was performed from 0339 to 0856 on December 14, 2003. The final reactor coolant system boron concentration, after allowing system to mix, was 1776 ppmB. Figure 2 shows ICRR versus volume of water used.

2.4 Control Rod Drop Timing Test

This testing is performed prior to each post-refueling startup to verify that, when dropped from the fully withdrawn position at Hot, No-load conditions, each Rod Cluster Control Assembly (RCCA) completely inserts and that its drop time is ≤ 2.2 seconds (pursuant to Technical Specification Surveillance Requirement 3.1.4.3). The 2.2 second criterion applies to the time measured from beginning of decay of Stationary Gripper coil voltage to Dash Pot entry.

All BOC15 RCCA drop times satisfied the acceptance criterion. Table 2 summarizes not only the BOC15 data, but, for comparison purposes, the BOC14 drop times as well. It should be noted that "Time to DP" is the data to be compared to the 2.2 second criterion. "Time to DP" is a parameter that is measured for the purposes of assessing resistance to the RCCA in the Dash Pot region, which was at one time postulated to be the culprit in increasing drop times industry wide.

TABLE 2
CYCLE 14 AND CYCLE 15 ROD DROP TIMING RESULTS

		1BOC14—5/02				1BOC15—12/03	
Bank	Rod ID	Time to DP	Time to DP Bottom	Bank	Rod ID	Time to DP	Time to DP Bottom
CBA	H06	1.553	2.014	CBA	H06	1.533	2.033
	H10	1.513	1.994		H10	1.493	1.993
	F08	1.553	2.074		F08	1.553	2.073
	K08	1.554	2.075		K08	1.534	2.114
CBB	F02	1.534	2.054	CBB	F02	1.554	2.115
	B10	1.534	2.034		B10	1.554	2.095
	K14	1.594	2.134		K14	1.614	2.195
	P06	1.555	2.035		P06	1.575	2.076
	B06	1.535	1.995		B06	1.555	2.056
	F14	1.555	2.095		F14	1.595	2.116
	P10	1.536	2.016		P10	1.556	2.097
	K02	1.536	2.076		K02	1.616	2.177
CBC	H02	1.576	2.096	CBC	H02	1.556	2.097
	B08	1.517	2.037		B08	1.517	2.058
	H14	1.517	2.017		H14	1.537	2.058
	P08	1.577	2.057		P08	1.557	2.058
	F06	1.558	2.038		F06	1.538	2.019
	F10	1.558	2.078		F10	1.518	2.019
	K10	1.538	2.058		K10	1.538	2.059
	K06	1.538	2.038		K06	1.538	2.039
CBD	D04	1.539	2.039	CBD	D04	1.539	2.060
	M12	1.519	2.019		M12	1.519	2.060
	D12	1.539	2.039		D12	1.519	2.060
	M04	1.540	2.060		M04	1.520	2.061
	H08	1.540	2.060		H08	1.520	2.041
SBA	D02	1.604	2.124	SBA	D02	1.584	2.165
	B12	1.544	2.064		B12	1.544	2.085
	M14	1.645	2.165		M14	1.605	2.146
	P04	1.545	2.065		P04	1.545	2.066
	B04	1.585	2.085		B04	1.585	2.086
	D14	1.626	2.146		D14	1.626	2.167
	P12	1.586	2.086		P12	1.586	2.107
	M02	1.606	2.146		M02	1.586	2.147
SBB	G03	1.606	2.106	SBB	G03	1.586	2.107
	C09	1.567	2.067		C09	1.547	2.068
	J13	1.547	2.067		J13	1.547	2.048
	N07	1.567	2.067		N07	1.527	2.048
	C07	1.548	2.068		C07	1.548	2.069
	G13	1.588	2.128		G13	1.568	2.109
	N09	1.568	2.068		N09	1.568	2.109
	J03	1.549	2.049		J03	1.529	2.030
SBC	E03	1.569	2.109	SBC	E03	1.569	2.070
	C11	1.529	2.009	*	C11	1.529	2.030
	L13	1.570	2.030		L13	1.570	2.071
	N05	1.530	2.030	*	N05	1.530	2.091
SBD	C05	1.550	2.070	SBD *	C05	1.550	2.071
	E13	1.550	2.070		E13	1.550	2.071
	N11	1.531	2.051	*	N11	1.531	2.032
	L03	1.571	2.051		L03	1.551	2.112
SBE	H04	1.531	2.011	SBE	H04	1.511	2.032
	D08	1.552	2.092		D08	1.552	2.073
	H12	1.532	2.052		H12	1.512	2.093
	M08	1.552	2.072		M08	1.552	2.093

***NGF Lead Test Assembly locations**

FIGURE 1
CORE LOADING PATTERN, CATAWBA 1 CYCLE 15

180°

90°

270°

1					ZA10 PD	ZC4A PD	AA71 PD O	ZA30 PD	AA41 PD O	ZC36 PD	ZA06 PD				
2			AA19 PD O	ZC21 R320	ZD3A PD	ZD55 R346	ZD46 PD	ZD01 R325	ZD4A PD	ZD5A R327	ZD40 PD	ZC23 R326	AA40 PD O		
3		AA61 PD O	ZA44 PD	ZD60 PD	ZD20 R310	ZC63 PD	ZC53 R333	ZD06 8W09C	ZC54 R309	ZC6A PD	ZD94 R337	ZD66 PD	ZA43 PD	AA18 PD O	
4		ZC1A R350	ZD69 PD	ZC60 R330	ZC96 PD	ZCA4 PD	ZD23 8W103	ZC12 R316	ZD26 8W106	ZC9C PD	ZC91 PD	ZC5C R315	ZD54 PD	ZC31 R345	
5	ZA22 PD	ZD41 PD	ZD99 R340	ZC94 PD	ZC06 PD	ZD93 8W120	ZC49 PD	ZD2A 8W10C	ZC34 PD	ZD34 8W114	ZC03 PD	ZC93 PD	ZD1A R342	ZD42 PD	ZA36 PD
6	ZC35 PD	ZD6A R301	ZC61 SS	ZCA2 PD	ZD35 8W115	ZC2A R319	ZD10 PD	ZC13 R323	ZD12 PD	ZC19 R338	ZD92 8W119	ZCA1 PD	ZC69 PD	ZD56 R306	ZC3A PD
7	AA46 PD O	ZD4C PD	ZC50 R339	ZD22 8W102	ZC40 PD	ZD13 PD	ZC20 PD	ZC04 PD	ZC2C PD	ZD14 PD	ZC46 PD	ZD36 8W116	ZC52 R343	ZD50 PD	AA28 PD O
8	ZA34 PD	ZD02 R311	ZD05 8W09A	ZC14 R308	ZD24 8W104	ZC11 R303	ZC05 PD	ZD6C R314	ZC01 PD	ZC10 R302	ZD31 8W111	ZC15 R352	ZD09 8W099	ZD03 R300	ZA12 PD
9	AA69 PD O	ZD51 PD	ZC56 R344	ZD32 8W112	ZC39 PD	ZD15 PD	ZC1C PD	ZC0A PD	ZC29 PD	ZD0C PD	ZC3C PD	ZD2C 8W109	ZC51 R312	ZD45 PD	AA45 PD O
10	ZC33 PD	ZD63 R351	ZC66 PD	ZC99 PD	ZD91 8W11C	ZC22 R324	ZD16 PD	ZC0C R329	ZD11 PD	ZC32 R341	ZD30 8W110	ZCA3 PD	ZC65 SS	ZD64 R349	ZC45 PD
11	ZA24 PD	ZD43 PD	ZD19 R304	ZC6C PD	ZC02 PD	ZD25 8W105	ZC41 PD	ZD29 8W10A	ZC42 PD	ZD90 8W11A	ZC09 PD	ZC95 PD	ZD96 R307	ZD39 PD	ZA14 PD
12		ZC26 R332	ZD61 PD	ZC5A R318	ZC90 PD	ZC9A PD	ZD21 8W101	ZC16 R321	ZD33 8W113	ZCA0 PD	ZC92 PD	ZC59 R305	ZD62 PD	ZC25 R336	
13		AA50 PD O	ZA42 PD	ZD59 PD	ZD95 R322	ZC64 PD	ZC55 R334	ZD0A 8W100	ZC4C R313	ZC62 PD	ZD1C R331	ZD5C PD	ZA41 PD	AA13 PD O	
14			AA59 PD O	ZC24 R347	ZD44 PD	ZD53 R335	ZD52 PD	ZD04 R348	ZD49 PD	ZD65 R328	ZD3C PD	ZC30 R317	AA60 PD O		
15					ZA1C PD	ZC43 PD	AA35 PD O	ZA39 PD	AA43 PD O	ZC44 PD	ZA16 PD				
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A

0°

FUEL ID: AA** = BATCH 11, ZA** = BATCH 15, ZC**=BATCH 16, ZD** = BATCH 17

COMPONENT ID. R***=CONTROL ROD; SS=SECONDARY SOURCE; **W***=BURNABLE POISON;
PD = PLUGGING DEVICE (THIMBLE PLUG).

O Cycle 11 Reinserts
O Cycle 10 Reinserts

TABLE 3
PRELIMINARY NIS CALIBRATION DATA

Intermediate Range

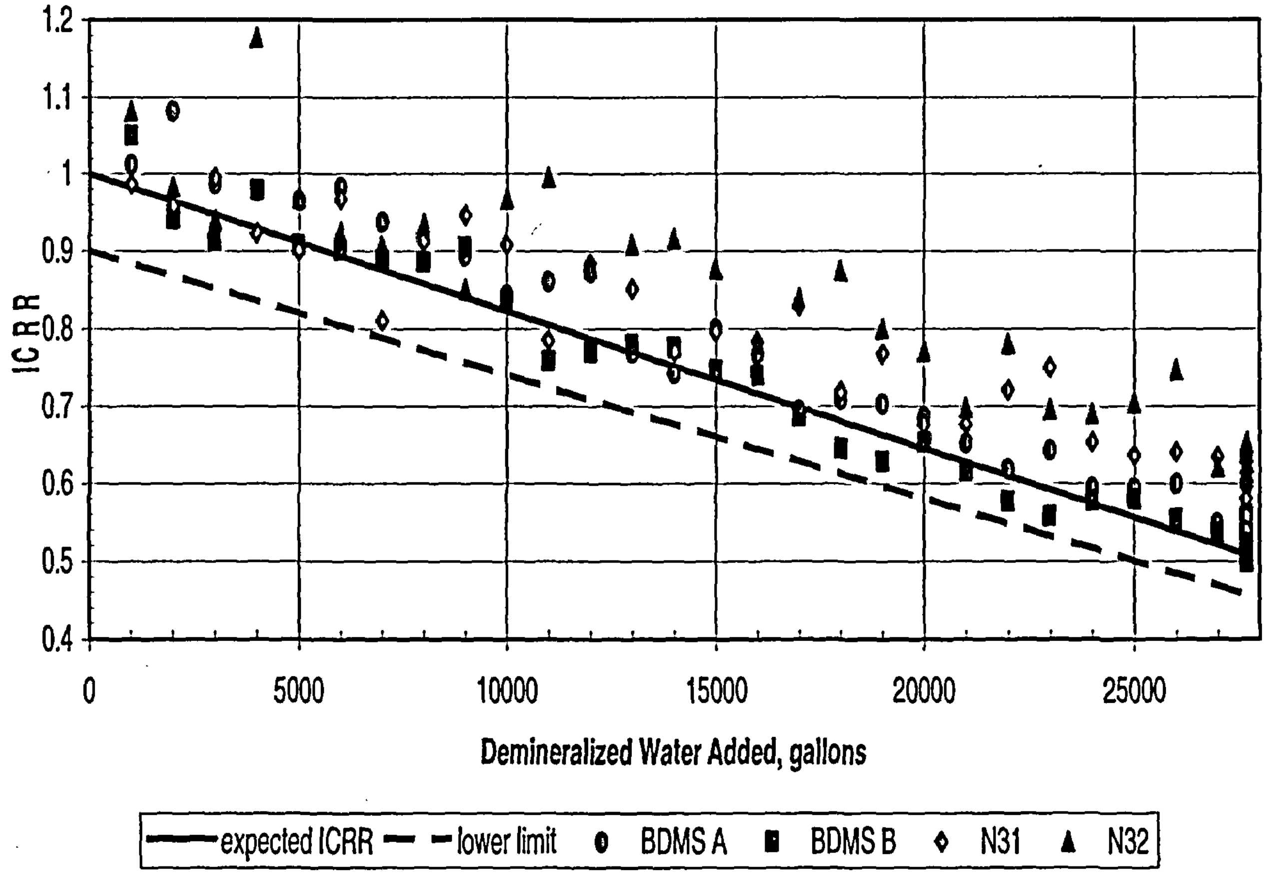
Channel	Ratio (BOC 15 + Cycle 14)	Cycle 14 Reactor Trip Setpoint, Amps	BOC 15 Reactor Trip Setpoint, Amps	BOC 13 Rod Stop Setpoint, μAmps
N35	0.7972	6.851 E-05	5.462 E-05	4.370 E-05
N36	0.7410	7.899 E-05	5.853 E-05	4.682 E-05

Power Range

Channel	Ratio (BOC 15 + Cycle 14)	Axial Offset, %	Cycle 14 Full Power Current, μAmps		BOC 15 Full Power Current, μAmps	
			Upper	Lower	Upper	Lower
N41	0.7468	+20	293.9	237.1	219.5	177.1
		0	254.6	277.3	190.1	207.1
		-20	215.2	317.5	160.7	237.1
N42	0.7277	+20	286.0	212.8	208.1	154.9
		0	247.0	248.6	179.7	180.9
		-20	207.9	284.4	151.3	207.0
N43	0.7442	+20	283.0	219.3	210.6	163.2
		0	246.2	257.9	183.2	191.9
		-20	209.4	296.5	155.8	220.7
N44	0.7477	+20	226.1	181.2	169.1	135.5
		0	195.6	213.1	146.3	159.3
		-20	165.0	245.1	123.4	183.3

FIGURE 2

ICRR vs. DEMIN WATER ADDED DURING REACTOR COOLANT SYSTEM DILUTION



3.0 ZERO POWER PHYSICS TESTING

Zero Power Physics Testing (ZPPT) is performed at the beginning of each cycle and is controlled by PT/0/A/4150/01, Controlling Procedure for Startup Physics Testing, and PT/0/A/4150/01A, Zero Power Physics Testing. Test measurements are made below the Point of Nuclear Heat Addition using the output of one Power Range NIS detector connected to a Westinghouse Advanced Digital Reactivity Computer (ADRC). Measurements are compared to predicted data to verify core design. The following tests/measurements are included in the ZPPT program:

- 1/M Approach to Criticality
- Reactivity Computer checkout
- Measurement of Point of Nuclear Heat Addition
- Control Rod Worth Measurements via Dynamic Rod Worth Measurement
- All Rods Out Critical Boron Concentration measurement
- All Rods Out Isothermal Temperature Coefficient measurement

Zero power physics testing for Catawba 1 Cycle 15 began at 2200 on December 18, 2003 commencing with implementation of bucking (gamma compensation) current on the ADRC. ZPPT concluded at 0545 on December 19, 2003 with completion of the ITC Measurement. Table 4 summarizes results from ZPPT. All acceptance criteria were met.

Sections 3.1 through 3.10 describe ZPPT measurements and results.

3.1 1/M Approach to Criticality

Initial criticality for Catawba 1 Cycle 15 was achieved per PT/0/A/4150/19, 1/M Approach to Criticality. In this procedure, Estimated Critical Rod Position (ECP) is calculated based on latest available Reactor Coolant boron concentration. Control rods are withdrawn until BDMS or Source Range (S/R) NIS count rates double. ICRR is plotted for each S/R NIS and BDMS channel. ICRR data is used to project critical rod position. If projected critical rod position is acceptable, rod withdrawal may continue.

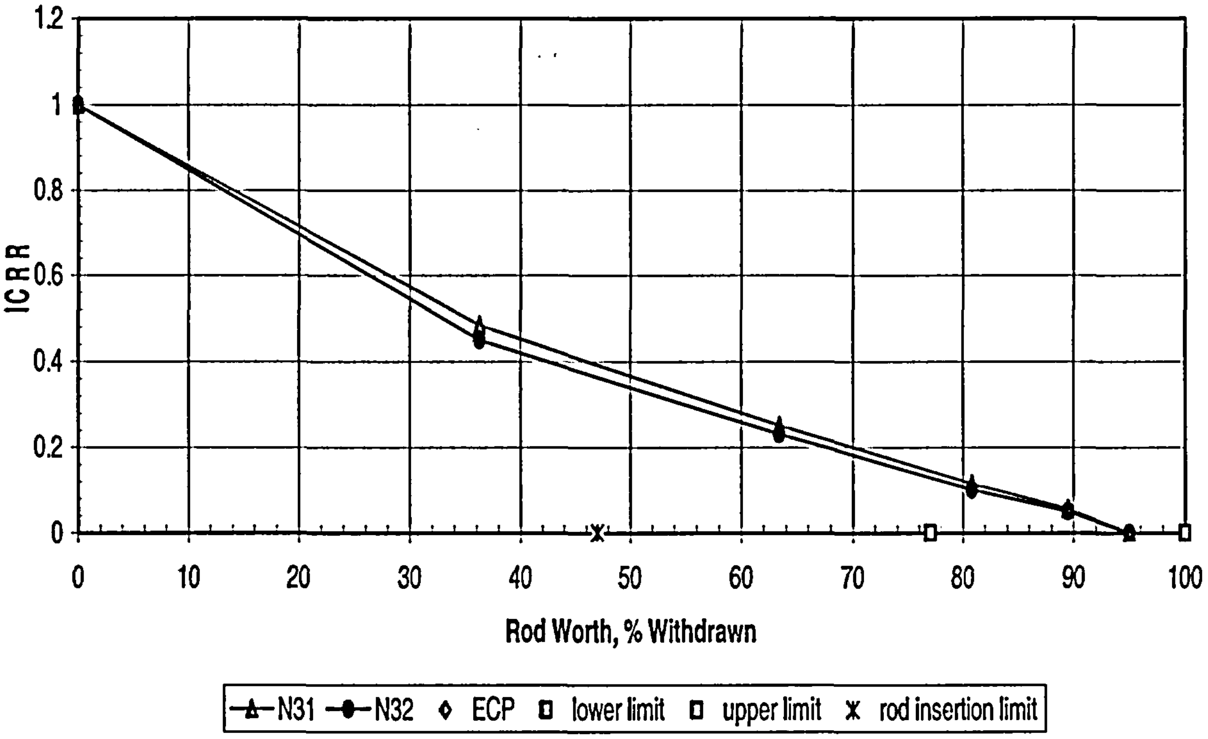
The ECP for C1C15 initial criticality was determined to be Control Bank D at 226 SWD. Rod withdrawal for the approach to criticality began at 2220 with Criticality subsequently achieved at 2315 on December 18, 2003 at a control rod position of 188 SWD on Control Bank D.

Figure 3 shows the S/R NIS ICRR behavior during the approach to criticality. All acceptance criteria of PT/0/A/4150/19 were met.

TABLE 4
SUMMARY OF ZPPT RESULTS

PARAMETER	MEASURED VALUE	PREDICTED VALUE OR ACCEPTANCE CRITERIA
Nuclear Heat	6.174×10^{-7} amps (N41)	N/A
ZPPT Test Limit	5.557×10^{-7} amps (N41)	N/A
ARO Critical Boron	1879 ppmB	1845 ± 50 ppmB
ARO ITC	-4.26 pcm/°F	-4.04 ± 2 pcm/°F
ARO MTC	-2.60 pcm/°F	-2.38 pcm/°F
Control Bank D Worth	750.3 pcm	689 ± 103.4 pcm
Control Bank C Worth	822.8 pcm	816 ± 122.4 pcm
Control Bank B Worth	635.4 pcm	659 ± 100 pcm
Control Bank A Worth	367.7 pcm	349 ± 100 pcm
Shutdown Bank E Worth	397.9 pcm	418 ± 100 pcm
Shutdown Bank D Worth	456.3 pcm	445 ± 100 pcm
Shutdown Bank C Worth	437.7 pcm	442 ± 100 pcm
Shutdown Bank B Worth	813.2 pcm	855 ± 128.3 pcm
Shutdown Bank A Worth	220.0 pcm	224 ± 100 pcm
Total Rod Worth	4901.3 pcm	4897 ± 391.8 pcm

FIGURE 3
ICRR vs. CONTROL ROD WORTH DURING APPROACH TO CRITICALITY



3.2 Reactivity Computer Checkout

The reactivity computer checkout was performed per PT/0/A/4150/01A, Zero Power Physics Testing, to verify that the Power Range channel connected to the reactivity computer can provide reliable reactivity data. A Reactivity Insertion of between +25 and +40 pcm via control rod withdrawal is used to establish a slow, stable startup rate over which determination of Reactor Period is performed by the ADRC. The resulting Period is then used by the ADRC to determine the corresponding Theoretical Reactivity. Measured Reactivity is compared to the Theoretical Reactivity and verified to be within 4.0% or 1.0 pcm (whichever is greater). This evolution is repeated as necessary to ensure compliance with acceptance criterion.

The checkout was performed for Cycle 15 on December 19, 2003. Results are summarized in Table 5.

TABLE 5
REACTIVITY COMPUTER CHECKOUT

Period (seconds)	Theoretical Reactivity (pcm)	Measured Reactivity (pcm)	Absolute Error (pcm)	Percent Error (%)
199.7	31.0	30.3	0.7	-2.27

3.3 Point of Nuclear Heat Addition

The Point of Nuclear Heat Addition is measured by trending Reactor Coolant System temperature, Pressurizer level, flux level, and reactivity while slowly increasing reactor power. A slow, constant startup rate is initiated by rod withdrawal. An increase in Reactor Coolant System temperature and/or Pressurizer level accompanied by a change in reactivity and/or rate of flux increase indicates the addition of Nuclear Heat.

For Cycle 15, the Point of Nuclear Heat Addition was determined per PT/0/A/4150/01A, Zero Power Physics Testing, on December 19, 2003. Table 6 summarizes the data obtained.

The Zero Power Physics Test Limit was set at 7.11×10^{-7} amps on Power Range channel N41 (connected to reactivity computer). This test limit provides 10% margin to Nuclear Heat for performance of Dynamic Rod Worth Measurement.

TABLE 6
NUCLEAR HEAT DETERMINATION

Reactivity Computer (N41), amps	Intermediate Range Channel N35, amps	Intermediate Range Channel N36, amps
7.90×10^{-7}	6.174×10^{-7}	6.947×10^{-7}

3.4 Dynamic Rod Worth Measurement

Using the Westinghouse Advanced Digital Reactivity Computer (ADRC), the reactivity worth of each RCCA Bank is measured using Dynamic Rod Worth Measurement (DRWM) technique as follows:

- Control Bank D is withdrawn (in MANUAL) to fully withdrawn position
- Flux level is allowed to increase to just below ZPPT Test Limit
- First RCCA Bank to be measured is inserted in Bank Select Mode in one continuous motion to a Step Demand Counter indication of ~ 2 Steps Wd
- Once the ADRC has signaled that it has acquired sufficient data for measurement, the RCCA Bank is returned to fully withdrawn position
- The next Bank to be tested is then selected and, once flux level has recovered to just below ZPPT Test Limit, the measurement process is repeated
- This test sequence is repeated until all Control and Shutdown Banks have been measured

The measured worth of each RCCA Bank is verified to be within 15% or 100 pcm (whichever criteria is greater) of predicted worth. The sum of the worths of all banks is verified to be within 8% of the sum of predicted worths. This sum is also verified to be ≥ 90% of the predicted total.

The Beginning of Cycle 15 rod worth measurements via DRWM were performed on December 19, 2003 per PT/0/A/4150/01A, Zero Power Physics Testing. Results are summarized in Table 4. All acceptance criteria were met.

3.5 ARO Boron Endpoint Measurement

This test is performed at the beginning of each cycle to verify that measured and predicted total core reactivity are consistent. The test is performed in conjunction with DRWM. Reactor Coolant System boron samples are obtained at 30 minute intervals during DRWM. The reactivity difference from criticality to the all rods out (ARO) configuration is measured 9 times over the course of DRWM. These reactivities are averaged to determine the amount of control rod insertion at just critical core conditions. This reactivity is converted to equivalent boron (using the predicted differential boron worth) and added to the average of the boron samples obtained during DRWM to obtain the ARO critical boron concentration.

The Cycle 15 beginning of cycle, hot zero power, all rods out, critical boron concentration was measured on December 19, 2003 per PT/0/A/4150/01A, Zero Power Physics Testing. The ARO, HZP boron concentration was measured to be 1879 ppmB. Predicted ARO critical boron concentration was 1845 ppmB. The acceptance criterion (measured boron within 50 ppmB of predicted) was therefore met.

3.6 ARO Isothermal Temperature Coefficient Measurement

The ARO Isothermal Temperature Coefficient (ITC) is measured at the beginning of each cycle to verify consistency with predicted value. In addition, the Moderator Temperature Coefficient (MTC) is obtained by subtracting the Doppler Temperature Coefficient from the ITC. The MTC is used to ensure compliance with Technical Specification limits.

The Isothermal Temperature Coefficient of Reactivity is measured as follows:

- A cooldown at ~10 °F/hour is initiated.
- Once a constant cooldown rate is established, data gathering on the reactivity computer is initiated.
- After at least 1.1 °F of data is obtained and the error analysis performed by the reactivity computer indicates < 0.1, the cooldown is halted.
- A heatup at ~10 °F/hour back to 557 °F is then initiated. Once a constant heat-up rate is established, data gathering on reactivity computer is initiated and subsequently halted when measurement criteria are satisfied.

Control rod motion is limited to that required to maintain flux below the testing limit. The cooldown/heatup cycle is repeated if additional data is required.

The Beginning of Cycle 15 ITC was measured per PT/0/A/4150/01A, Zero Power Physics Testing, December 19, 2003. No additional cooldown/heatup cycles were required due to good agreement between initial heatup and cooldown results (difference between the measurements ≤ 1.0 pcm/°F). Table 7 summarizes the data obtained during the measurement.

Average ITC was determined to be –4.26 pcm/°F. Predicted ITC was –4.04 pcm/°F. Measured ITC was therefore within acceptance criterion of predicted ITC ± 2 pcm/°F.

The MTC was determined to be –2.60 pcm/°F. Since the MTC was measured to be negative, compliance with Tech Spec 3.1.3 and SR 3.1.3.1 was ensured without performance of procedure PT/0/A/4150/21, Temporary Rod Withdrawal Limits Determination. Performance of this procedure was waived per PT/0/A/4150/01, Controlling Procedure for Startup Physics Testing.

TABLE 7
ITC MEASUREMENT RESULTS

	Average Temp (°F)	ITC (pcm/°F)
Cooldown	556.3	-4.22
Heatup	556.6	-4.29
Average	556.5	-4.26

4.0 POWER ESCALATION TESTING

Power Escalation Testing is performed during the initial power ascension to full power for each cycle and is controlled by PT/0/A/4150/01, Controlling Procedure for Startup Physics Testing. Tests are performed from 0% through 100% power with major testing plateaus at ~18%,~50%, and 100% power.

Significant tests performed during C1C15 Power Escalation were:

- Core Power Distribution (at ~18, ~50, and 100% power)
- One-Point Incore/Excore Calibration (at ~50% power)
- Reactor Coolant Delta Temperature Measurement (at 74% and 100% power)
- Hot Full Power Critical Boron Concentration Measurement (at 100% power)
- Incore/Excore Calibration (at 100% power)
- Calorimetric Reactor Coolant Flow Measurement (at 100% power, This test is not under the control of PT/0/A/4150/01)
- Evaluation of Intermediate Range NIS Rod Stop and Rx Trip Setpoints

In addition to the tests listed above, PT/0/A/4150/01 performs evaluations of the Movable Incore Detector System, and on-line (OAC) Thermal Power program. The results of these are not included in this report.

Although ZPPT for Catawba 1 Cycle 15 was completed on December 19, 2003, Power Escalation Testing was not commenced until December 31, 2003. During this interval, Reactor Power was limited to 10% Full Power (F.P.) due to unavailability of the Main Generator (due to Hydrogen Cooler seal leakage). Full power was reached on January 3, 2004. Full power testing was completed on January 8, 2004. Sections 4.1 through 4.7 describe the significant tests performed during power escalation and their results.

4.1 Core Power Distribution

Core power distribution measurements are performed during power escalation at Low Power (< 40% F.P.), Intermediate Power (between 40% F.P. and 80% F.P.), and High Power (> 90% F.P.). Measurements are made to verify flux symmetry and to verify core peaking factors are within limits. Data obtained during this test are also used to check calibration of Power Range NIS channels and to calibrate them if required (see Sections 4.2 and 4.6). Measurements are made using the Moveable Incore Detector System and analyzed using Duke Power's COMET code (evolved from Shanstrom Nuclear Associates' CORE package and FCF's MONITOR code, respectively).

The Catawba 1 Cycle 15 Core Power Distribution measurements were performed on December 31, 2003 (18% power), January 1, 2004 (50% power), and January 6, 2004 (100% power). Tables 8 through 10 summarize the results. All acceptance criteria were met.

TABLE 8
CORE POWER DISTRIBUTION RESULTS
18% POWER

Plant Data

Map ID:	FCM/1/15/001
Date of Map:	December 31, 2003
Cycle Burnup:	1.091 EFPD
Power Level:	17.698% F.P.
Control Rod Position:	Control Bank D at 210 Steps Wd
Reactor Coolant System Boron Concentration:	1707 ppmB

COMET Results

Core Average Axial Offset:	26.929%
Tilt Ratios for Entire Core Height: Quadrant 1:	1.01743
Quadrant 2:	1.00553
Quadrant 3:	0.99935
Quadrant 4:	0.97769
Maximum F_Q (nuclear):	2.358
Maximum $F_{\Delta H}$ (nuclear):	1.517
Maximum Error between Pred. and Meas $F_{\Delta H}$:	8.99%
Average Error between Pred. and Meas. $F_{\Delta H}$:	2.99%
Maximum Error between Expected and Measured Detector Response:	9.17%
RMS of Errors between Expected and Measured Detector Response:	3.87%
Minimum F_Q Operational Margin:	25.80%
Minimum F_Q RPS Margin:	4.89%
Minimum F_Q Steady State Margin:	49.00%
Minimum $F_{\Delta H}$ Surveillance Margin:	24.09%
Minimum $F_{\Delta H}$ Steady State Margin:	21.25%

TABLE 9
CORE POWER DISTRIBUTION RESULTS
50% POWER

Plant Data

Map ID:	FCM/1/13/002
Date of Map:	January 1, 2004
Cycle Burnup:	1.369 EFPD
Power Level:	49.39% F.P.
Control Rod Position:	Control Bank D at 215 Steps Wd
Reactor Coolant System Boron Concentration:	1618 ppmB

COMET Results

Core Average Axial Offset:	9.133%
Tilt Ratios for Entire Core Height: Quadrant 1:	1.01417
Quadrant 2:	1.00171
Quadrant 3:	1.00064
Quadrant 4:	0.98349
Maximum F_Q (nuclear):	1.905
Maximum $F_{\Delta H}$ (nuclear):	1.498
Maximum Error between Pred. and Meas $F_{\Delta H}$:	9.58%
Average Error between Pred. and Meas. $F_{\Delta H}$:	3.31%
Maximum Error between Expected and Measured Detector Response:	10.50% *
RMS of Errors between Expected and Measured Detector Response:	4.20%
Minimum F_Q Operational Margin:	23.48%
Minimum F_Q RPS Margin:	9.5%
Minimum F_Q Steady State Margin:	58.80%
Minimum $F_{\Delta H}$ Surveillance Margin:	23.78%
Minimum $F_{\Delta H}$ Steady State Margin:	27.28%

* Nuclear Design and Reactor Support (NDRS) reviewed the 50% flux map, with particular attention to errors which challenged the UFSAR Section 14.3.3 acceptance criteria for Flux Symmetry check. Errors determined to be attributable to unanalyzed Shutdown Cooling (Pu build-in) sustained by Mark-BW reinsert assemblies during extended period in Spent Fuel Pool. Based on NDRS recommendation, power ascension continued to allow evaluation of core power distribution at Full Power. NDRS evaluation is documented in PT/0/A/4150/001.

TABLE 10
CORE POWER DISTRIBUTION RESULTS
100% POWER

Plant Data

Map ID:	FCM/1/15/003
Date of Map:	January 6, 2004
Cycle Burnup:	5.377 EFPD
Power Level:	99.854% F.P.
Control Rod Position:	Control Bank D at 215 Steps Wd
Reactor Coolant System Boron Concentration:	1230 ppmB

COMET Results

Core Average Axial Offset:	-1.391%
Tilt Ratios for Entire Core Height: Quadrant 1:	1.01316
Quadrant 2:	0.99808
Quadrant 3:	0.99531
Quadrant 4:	0.99345
Maximum F_Q (nuclear):	1.728
Maximum $F_{\Delta H}$ (nuclear):	1.512
Maximum Error between Pred. and Meas $F_{\Delta H}$:	7.76%
Average Error between Pred. and Meas. $F_{\Delta H}$:	3.01%
Maximum Error between Expected and Measured Detector Response:	8.15% *
RMS of Errors between Expected and Measured Detector Response:	3.79%
Minimum F_Q Operational Margin:	0.17%
Minimum F_Q RPS Margin:	8.12%
Minimum F_Q Steady State Margin:	25.28%
Minimum $F_{\Delta H}$ Surveillance Margin:	11.96%
Minimum $F_{\Delta H}$ Steady State Margin:	19.43%

* Reaction Rate Error in excess of 10% noted at 50% F.P. now within UFSAR Section 14.3.3 Flux Symmetry check criteria due to depletion of excess plutonium in Mark-BW reinsert assemblies.

4.2 One-Point Incore/Excore Calibration

PT/0/A/4600/05D, One-Point Incore/Excore Calibration, is performed as necessary using results of Power Range (P/R) NIS data taken during power ascension flux maps and measured incore axial offset obtained from them. Calibration of the P/R NIS is necessary if difference between indicated excore and measured incore AFD exceeds 2%. For C1C15 Startup, no calibration was necessary for Low Power Flux Map. However, calibration was required by the Intermediate Power Level Flux Map (obtained at 50% F.P.). Power Range channel calibration was required to be completed prior to exceeding 90% in order to have valid indications of Axial Flux Difference and Quadrant Power Tilt Ratio for subsequent power ascension.

Data for the Intermediate Power Level calibration was obtained on January 1, 2004 and all P/R NIS calibrations were completed on January 2, 2004. Results are presented in Table 11. All acceptance criteria were met.

TABLE 11
INTERMEDIATE POWER LEVEL
ONE-POINT INCORE/EXCORE CALIBRATION RESULTS

Reactor Power = 49.39% Axial Offset = 9.133%

Measured Power Range Currents, μAmps

	N41	N42	N43	N44
Upper	78.1	81.4	77.0	61.2
Lower	75.0	73.8	70.7	60.5

Ratio, Extrapolated (from measured) Currents to "Expected" (from last calibration) Currents

	N41	N42	N43	N44
Upper	0.6409	0.6927	0.6671	0.6748
Lower	0.6497	0.7176	0.6665	0.6996

New Calibration Currents, μAmps

Axial Offset, %	N41		N42		N43		N44	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
+20	170.5	139.1	178.0	136.9	167.8	130.6	133.7	111.8
0	147.7	162.7	153.7	160.0	146.0	153.6	115.7	131.5
-20	124.8	186.3	129.4	183.0	124.1	176.6	97.6	151.3

4.3 Reactor Coolant Loop Delta Temperature Measurement

Reactor Coolant System Hot Leg and Cold Leg temperature data is obtained at a stable power level between 75% F.P. and 95% F.P.; and then subsequently at 100% F.P. per PT/0/A/4600/26, NC Temperature Calibration, to ensure that full power delta temperature constants (ΔT_0) are valid. ΔT_0 is used in the Overpower and Overtemperature Delta Temperature reactor protection functions.

In the case of C1C15, power ascension was halted at 94% F.P. on January 3, 2004, to allow evaluation of the four pre-existing loop ΔT_0's. All four channel constants were found to be unacceptable (calculated ΔT_0 constants exceeding existing constants by more than 0.6°F). New ΔT_0 constants were generated per PT/0/A/4600/026. Upon completion of ΔT Process Channel calibrations, power ascension was resumed. At 100% F.P., on January 5, 2004, ΔT_0's were re-evaluated, and all were found to be acceptable. Table 12 summarizes the test results.

TABLE 12
REACTOR COOLANT DELTA TEMPERATURE DATA

Reactor Power = 94.2048%

	Loop A	Loop B	Loop C	Loop D
Meas. T_{HOT}, °F	611.7	607.9	613.2	609.8
Meas. T_{COLD}, °F	552.0	551.8	551.7	552.7
Calc. Δh, BTU/lb	80.55820	75.08170	83.16302	76.79067
Calc. Δh_0, BTU/lb	85.51390	79.70100	88.27895	81.51460
Calc. ΔT_0, °F	63.1	59.2	64.9	60.3
Current ΔT_0, °F	61.7	58.0	63.7	59.5
Difference, °F	**+1.4**	**+1.2**	**+1.2**	**+0.8**

4.4 Hot Full Power Critical Boron Concentration Measurement

The Hot Full Power critical boron concentration is measured using PT/0/A/4150/04, Reactivity Anomaly Calculation. Reactor Coolant boron concentration is measured (average of three samples) with reactor at essentially all rods out, Hot Full Power, equilibrium xenon conditions. The measured boron is corrected for any off-reference condition (e.g. inserted rod worth, temperature error, difference from equilibrium xenon) and compared to predicted value.

A simple assessment of the accuracy of the predicted excess reactivity of the new core is performed by comparing the difference between predicted Beginning of Life HZP and HFP critical boron concentrations with the difference between measured BOL HZP and HFP critical boron concentrations. Acceptance criteria is met by verifying that Measured ΔBoron is within ±50 ppmB of Predicted ΔBoron.

For Catawba 1 Cycle 15, the Hot Full Power critical boron concentration was measured on January 5, 2004. The measured HFP, ARO critical boron concentration was 1234 ppmB. Predicted HFP critical boron concentration was 1219 ppmB. The ARO Boron Endpoint Measurement during ZPPT yielded a measured HZP Boron Concentration of 1879 ppmB (prediction being 1845 ppmB). The Predicted ΔBoron was therefore 626 ppmB, while the Measured ΔBoron was 645 ppmB. The difference of 19 ppmB between these two parameters satisfied the acceptance criterion.

4.5 Incore/Excore Calibration

Excore NIS Power Range channels are calibrated at full power per PT/0/A/4600/05A, Incore/Excore Calibration. Incore data (flux maps) and P/R NIS currents are obtained at various axial power distributions. A least squares fit of the output of each detector (upper and lower chambers) as a function of measured incore axial offset is determined. The slopes and intercepts of the fit for the upper and lower chamber for each channel are used to determine calibration data for that channel.

This test was performed for Catawba 1 Cycle 15 on January 6, 7 and 8, 2004. All Power Range NIS calibrations were completed on January 8. Nine flux maps, with axial offsets ranging from -12.007% to +6.006% were used. Table 13 summarizes the results. All acceptance criteria were met.

TABLE 13
INCORE/EXCORE CALIBRATION RESULTS

Full Power Currents, Microamps

Axial Offset, %	N41		N42		N43		N44	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
+20%	185.6	146.4	190.9	142.7	179.2	136.2	142.8	116.1
0%	161.4	172.4	166.3	167.9	156.7	160.7	124.8	137.7
-20%	137.2	198.4	141.7	193.1	134.2	185.2	106.8	159.3

Correction (M_J) Factors

N41	N42	N43	N44
1.328	1.342	1.351	1.327

4.6 Calorimetric Reactor Coolant Flow Measurement

With clean Main Feedwater Flow venturis, PT/1/A/4150/13B, Calorimetric Reactor Coolant Flow Measurement is performed to validate the Operator Aid Computer's calculations of Reactor Thermal Power and Reactor Coolant Flowrate.

The results of this test, performed for C1C15 on January 29, 2004, are summarized in Table 14. The test was not performed at Full Power due to reduction to 99% F.P. imposed by Digital Feedwater Control System malfunction. However, performance of this test at any power level > 97% F.P. is permissible. All acceptance criteria were met and adequate margin to Technical Specification Minimum Reactor Coolant Flow limit of 388,000 GPM was demonstrated.

TABLE 14
CALORIMETRIC REACTOR COOLANT FLOW MEASUREMENT

Run Number	Total Calculated Reactor Coolant Flow (GPM)	Percent Tech Spec Flow (%)	Calculated Thermal Power Level (%)
1	391,354	100.864	98.776
2	391,413	100.880	98.816
3	391,543	100.913	98.753
Average	391,437	100.886	98.782