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Subject: Catawba Nuclear Stations, Unit 1
Docket No. 50-413
Unit 1 Cycle 13 Startup Report

Catawba Unit 1 Cycle 13 is the first Catawba Unit 1 one cycle to implement the Westinghouse Robust Fuel Assembly (RFA). Power escalation testing, including first flux map at full power, was completed on 27 November 2000.

As required by Section 14.3.4 item (3) of the Catawba Updated Final Safety Analysis Report, the Unit 1 Startup Report for Catawba Unit 1 Cycle 13 core design is attached. This section requires a summary report to be submitted within 90 days following resumption of commercial power operation if the fuel has a different design. This report is being submitted outside the required timeframe due to an administrative oversight.

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,

for

Gary R. Peterson

Attachments

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IE26

Duke Power Company
Catawba Nuclear Station
Unit 1 Cycle 13
STARTUP REPORT

November 2000

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1.0 INTRODUCTION

C1C13 is the first Catawba Unit One cycle to implement the Westinghouse Robust Fuel Assembly (RFA). The C1C13 core consists of a feed batch of 76 of these fuel assemblies. The feed batch enrichments are 40 RFA's at 3.92% (w/o) with 6 inch 2.6% (w/o) annular blankets, and 36 F/A's at 4.47% (w/o) with 6 inch 2.6% (w/o) 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.

C1C13 core loading commenced at 2312 on November 5, 2000 and concluded at 0409 on November 8, 2000. Initial criticality for Cycle 13 occurred at 0420 on November 20, 2000. Zero Power Physics Testing was completed at 1230 on November 20, 2000. The unit reached full power at 0023 on November 25, 2000. Power Escalation testing, including first flux map at full power, was completed by 1415 on November 27, 2000.

Table 1 summarizes important characteristics of the Catawba 1 Cycle 13 core design.

TABLE 1
C1C13 CORE DESIGN DATA

1. C1C12 end of cycle burnup: 501 EFPD

2. C1C13 design length: 495 –10 / +10 EFPD

Region	Fuel Type	Number of Assemblies	Enrichment, w/o U^{235}	Loading, MTU*	Cycles Burned
11	MkBW	1	3.86	0.4562	3
13	MkBW	36	4.20/2.0**	16.4232	2
14	MkBW	80	4.73/2.0**	36.4960	1
15A	W RFA	40	3.92/2.0***	18.2160	0
15B	W RFA	36	4.47/2.0***	16.3944	0
Totals		193		87.9858	

* Design MTU loadings were used in all design calculations (currently 0.4562 for MkBW & 0.4554 for RFA).

** 2.00 w/o enriched Uranium blanketed fuel assemblies (6 inches top and bottom)

*** 2.60% (w/o) enriched annular Uranium blanket

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 13.

2.1 Total Core Reloading

The Cycle 13 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 2331 on November 5, 2000 and concluded at 0409 on November 8, 2000. Core loading was verified per PT/0/A/4550/03C, Core Verification, which was completed at 0730 on November 8, 2000.

Figure 1 shows the core loading pattern for Catawba 1 Cycle 13.

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 NIS Rod Stop and Rx 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 16, 2000. Calibrations were completed on November 18, 2000.

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. Inverse Count Rate Ratio (ICRR) was plotted versus gallons of demineralized water added.

Initial reactor coolant boron concentration was 2,407 ppmB. The estimated critical boron concentration was calculated to be 1472 ppmB. The calculated volume of demineralized water required was 33,275 gallons. This change in boron concentration was expected to decrease ICRR from 1.0 to 0.34.

Reactor coolant system dilution at 89.5 GPM was performed from 0529 to 1141 on November 19, 2000. The final reactor coolant system boron concentration, after allowing system to mix, was 1502 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 RCCA completely inserts and that it's drop time is ≤ 2.2 seconds (pursuant to Tech Spec 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 BOC13 RCCA drop times satisfied the acceptance criterion. Table 2 summarizes not only the BOC13 data, but, for comparison purposes, the BOC12 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 12 AND CYCLE 13 ROD DROP TIMING RESULTS

		1BOC12---5/99				1BOC13---11/00	
Bank	Rod ID	Time to DP	Time to DP Bottom	Bank	Rod ID	Time to DP	Time to DP Bottom
CBA	H06	1.62	2.21	CBA	H06	1.58	2.13
	H10	1.58	2.15		H10	1.53	2.08
	F08	1.63	2.22		F08	1.56	2.10
	K08	1.62	2.21		K08	1.59	2.13
CBB	F02	1.57	2.15	CBB	F02	1.56	2.08
	B10	1.57	2.12		B10	1.56	2.04
	K14	1.60	2.16		K14	1.60	2.09
	P06	1.57	2.11		P06	1.57	2.05
	B06	1.57	2.11		B06	1.78	2.25
	F14	1.60	2.18		F14	1.61	2.12
	P10	1.57	2.12		P10	1.55	2.03
	K02	1.60	2.16		K02	1.59	2.08
CBC	H02	1.60	2.16	CBC	H02	1.57	2.11
	B08	1.56	2.11		B08	1.54	2.07
	H14	1.55	2.09		H14	1.51	2.04
	P08	1.59	2.14		P08	1.56	2.09
	F06	1.56	2.10		F06	1.54	2.06
	F10	1.57	2.13		F10	1.54	2.07
	K10	1.58	2.13		K10	1.56	2.09
	K06	1.57	2.14		K06	1.54	2.06
CBD	D04	1.54	2.11	CBD	D04	1.54	2.07
	M12	1.55	2.13		M12	1.53	2.05
	D12	1.57	2.15		D12	1.53	2.06
	M04	1.56	2.15		M04	1.53	2.08
	H08	1.61	2.21		H08	1.55	2.09
SBA	D02	1.61	2.19	SBA	D02	1.57	2.11
	B12	1.58	2.14		B12	1.52	2.03
	M14	1.67	2.26		M14	1.62	2.16
	P04	1.58	2.13		P04	1.55	2.05
	B04	1.61	2.18		B04	1.56	2.08
	D14	1.67	2.24		D14	1.60	2.15
	P12	1.61	2.17		P12	1.57	2.05
	M02	1.62	2.20		M02	1.58	2.11
SBB	G03	1.57	2.15	SBB	G03	1.57	2.12
	C09	1.57	2.12		C09	1.54	2.08
	J13	1.56	2.13		J13	1.53	2.06
	N07	1.55	2.10		N07	1.54	2.05
	C07	1.57	2.13		C07	1.55	2.08
	G13	1.57	2.11		G13	1.57	2.12
	N09	1.54	2.12		N09	1.56	2.09
	J03	1.55	2.12		J03	1.52	2.05
SBC	E03	1.60	2.15	SBC	E03	1.57	2.10
	C11	1.55	2.11		C11	1.55	2.08
	L13	1.58	2.11		L13	1.53	2.06
	N05	1.59	2.14		N05	1.56	2.08
SBD	C05	1.61	2.16	SBD	C05	1.58	2.12
	E13	1.60	2.13		E13	1.55	2.08
	N11	1.58	2.13		N11	1.55	2.10
	L03	1.59	2.10		L03	1.54	2.09
SBE	H04	1.53	2.08	SBE	H04	1.55	2.09
	D08	1.60	2.16		D08	1.59	2.13
	H12	1.55	2.10		H12	1.52	2.04
	M08	1.57	2.11		M08	1.59	2.12

FIGURE 1
CORE LOADING PATTERN, CATAWBA 1 CYCLE 13

C1C13 FINAL CORE LOAD MAP

180°

FUEL TRANSFER CANAL ------->

90° (left) 270° (right)

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					AD02 PD	AD2C PD	AE90 PD	AD11 PD	AE12 PD	AD44 PD	AC05 PD ❶				
2			AD42 PD	AD5C R314	ZA46 4W01C	ZA90 R333	ZA55 8W015	AE3A R327	ZA5A 8W01C	ZA92 R325	ZA4A 4W020	AD15 R346	AD10 PD		
3		AD13 PD	ZA41 PD	ZA60 8W020	AE6C R347	AE66 PD	AE2C R318	ZA01 12W013	AE4A R328	AE9A PD	AE35 R316	ZA66 8W026	ZA42 PD	AD03 PD	
4		AD64 R352	ZA69 8W02A	AE26 R331	ZA09 16W06A	AE53 PD	ZA15 16W0A5	AE25 R320	ZA1A 16W0AC	AE69 PD	ZA2A 16W0CC	AE45 R309	ZA54 8W014	AD2A R308	
5	AC09 PD ❶	ZA4C 4W021	AE4C R345	ZA2C 16W0C9	AEA0 PD	ZA06 16W066	AE21 PD	ZA39 16W09A	AE94 PD	ZA10 16W0A0	AE20 PD	ZA23 16W0C3	AE15 R350	ZA50 4W022	AD5A PD
6	AD23 PD	ZA93 R306	AE34 PD	AE49 SS	ZA24 16W0C4	AE16 R339	ZA20 16W0C0	AE33 R329	ZA21 16W0C1	AE44 R332	ZA14 16W0A4	AE05 PD	AE01 PD	ZA94 R340	AD16 PD
7	AE6A PD	ZA6A 8W02C	AE36 R343	ZA19 16W0AA	AE61 PD	ZA05 16W065	AE23 PD	AE11 PD	AE9C PD	ZA29 16W0CA	AE62 PD	ZA13 16W0A3	AE60 R342	ZA56 8W016	AE09 PD
8	AD33 PD	AE41 R300	ZA02 12W014	AE0A R311	ZA12 16W0A2	AE65 R302	AE93 PD	AA47 R313 ❶	AE54 PD	AE96 R303	ZA34 16W094	AE5A R341	ZA03 12W015	AE10 R326	AD30 PD
9	AE91 PD	ZA63 8W023	AE03 R312	ZA32 16W092	AE04 PD	ZA26 16W0C6	AE42 PD	AE3C PD	AE40 PD	ZA40 16W100	AE0C PD	ZA25 16W0C5	AE52 R307	ZA64 8W024	AE19 PD
10	AD56 PD	ZA95 R349	AE39 PD	AE31 PD	ZA22 16W0C2	AE13 R323	ZA31 16W091	AE1C R304	ZA11 16W0A1	AE22 R344	ZA36 16W096	AE56 SS	AE1A PD	ZA6C R310	AD62 PD
11	AD53 PD	ZA51 4W023	AE24 R301	ZA0C 16W069	AE14 PD	ZA16 16W0A6	AE95 PD	ZA30 16W090	AE50 PD	ZA1C 16W0A9	AE99 PD	ZA33 16W093	AE02 R351	ZA45 4W01A	AC14 PD ❶
12		AD45 R336	ZA61 8W021	AE43 R334	ZA35 16W095	AE29 PD	ZA3C 16W099	AE32 R322	ZA0A 16W06C	AE2A PD	ZA3A 16W09C	AE5C R348	ZA62 8W022	AD63 R305	
13		AD1A PD	ZA43 PD	ZA59 8W01A	AE06 R315	AE46 PD	AE63 R337	ZA04 12W016	AE51 R324	AE30 PD	AE59 R338	ZA5C 8W019	ZA44 PD	AD43 PD	
14			AD4C PD	AD20 R319	ZA52 4W024	ZA96 R330	ZA53 8W013	AE64 R317	ZA65 8W025	ZA91 R335	ZA49 4W019	AD51 R321	AD12 PD		
15					AC2A PD ❶	AD6A PD	AE55 PD	AD91 PD	AE92 PD	AD66 PD	AD52 PD				

0°

☐ ---- FUEL ID: AA** = BATCH 11, AD** = BATCH 13, AE**=BATCH 14, ZA** = BATCH 15
---- COMPONENT ID: R***=CONTROL ROD; SS=SECONDARY SOURCE; **W***=BURNABLE POISON;
PD=PLUGGING DEVICE (THIMBLE PLUG).

❶ Cycle 11 Reinserts

TABLE 3
PRELIMINARY NIS CALIBRATION DATA

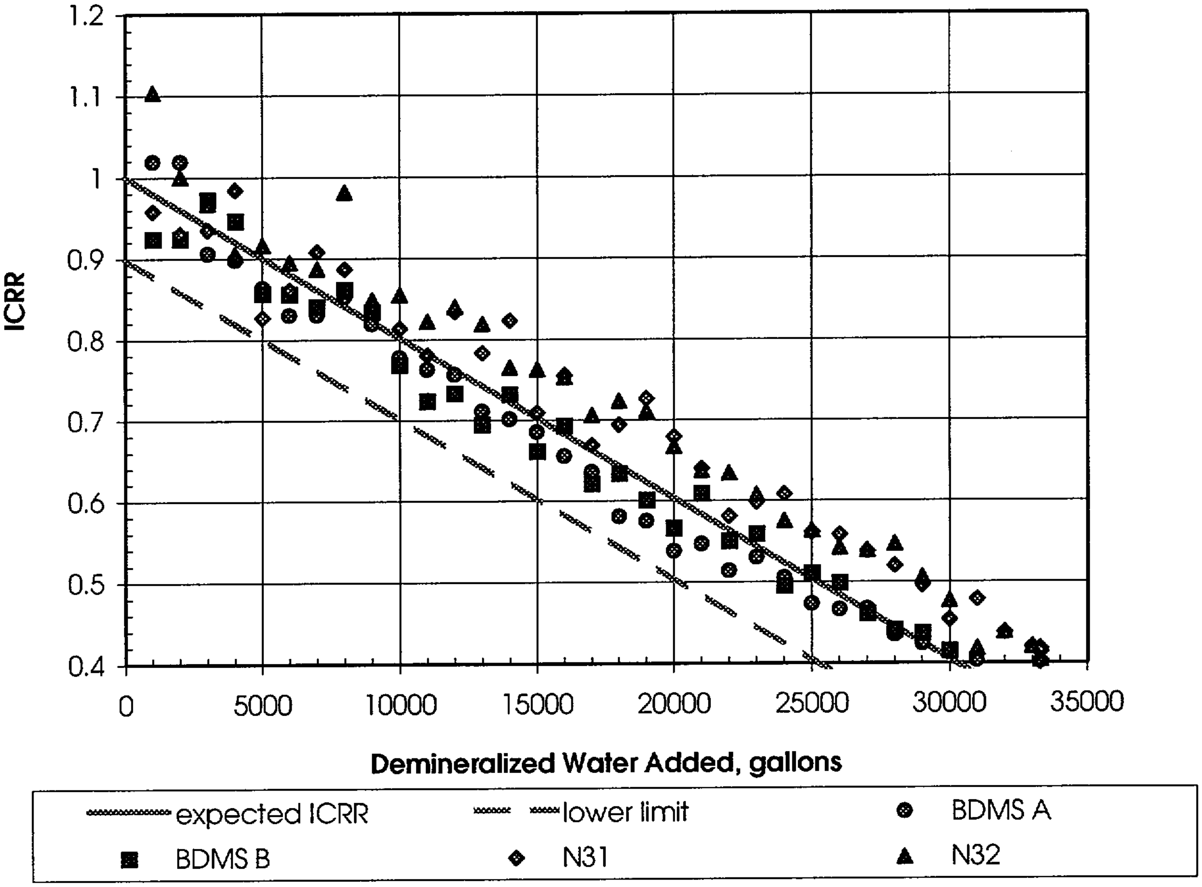
Intermediate Range

Channel	Ratio (BOC 13 ÷ Cycle 12)	Cycle 12 Reactor Trip Setpoint, μAmps	BOC 13 Reactor Trip Setpoint, μAmps	BOC 13 Rod Stop Setpoint, μAmps
N35	0.8056	66.06	59.61	42.58
N36	0.8088	63.68	57.69	41.20

Power Range

Channel	Ratio (BOC 13 ÷ Cycle 12)	Axial Offset, %	Cycle 12 Full Power Current, μAmps		BOC 13 Full Power Current, μAmps	
			Upper	Lower	Upper	Lower
N41	0.9545	+20	316.9	253.2	302.5	241.7
		0	273.0	294.3	260.6	280.9
		-20	229.2	335.4	218.8	320.1
N42	0.9270	+20	303.7	228.2	281.5	211.5
		0	262.2	265.2	243.1	245.8
		-20	220.8	302.2	204.7	280.1
N43	0.9553	+20	303.3	235.5	289.7	225.0
		0	261.5	274.2	249.8	261.9
		-20	219.7	312.9	209.9	298.9
N44	0.9569	+20	249.2	200.6	238.5	192.0
		0	214.4	232.9	205.2	222.9
		-20	179.6	265.2	171.9	253.8

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 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 13 began at 0340 on Novermber 20, 2000 commencing with a check of bucking (gamma compensation) current on the ADRC. ZPPT concluded at 1230 on November 20, 2000 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 13 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 Boron Dilution Mitigation System (BDMS) or Source Range NIS count rates double. Inverse Count Rate Ratio (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.

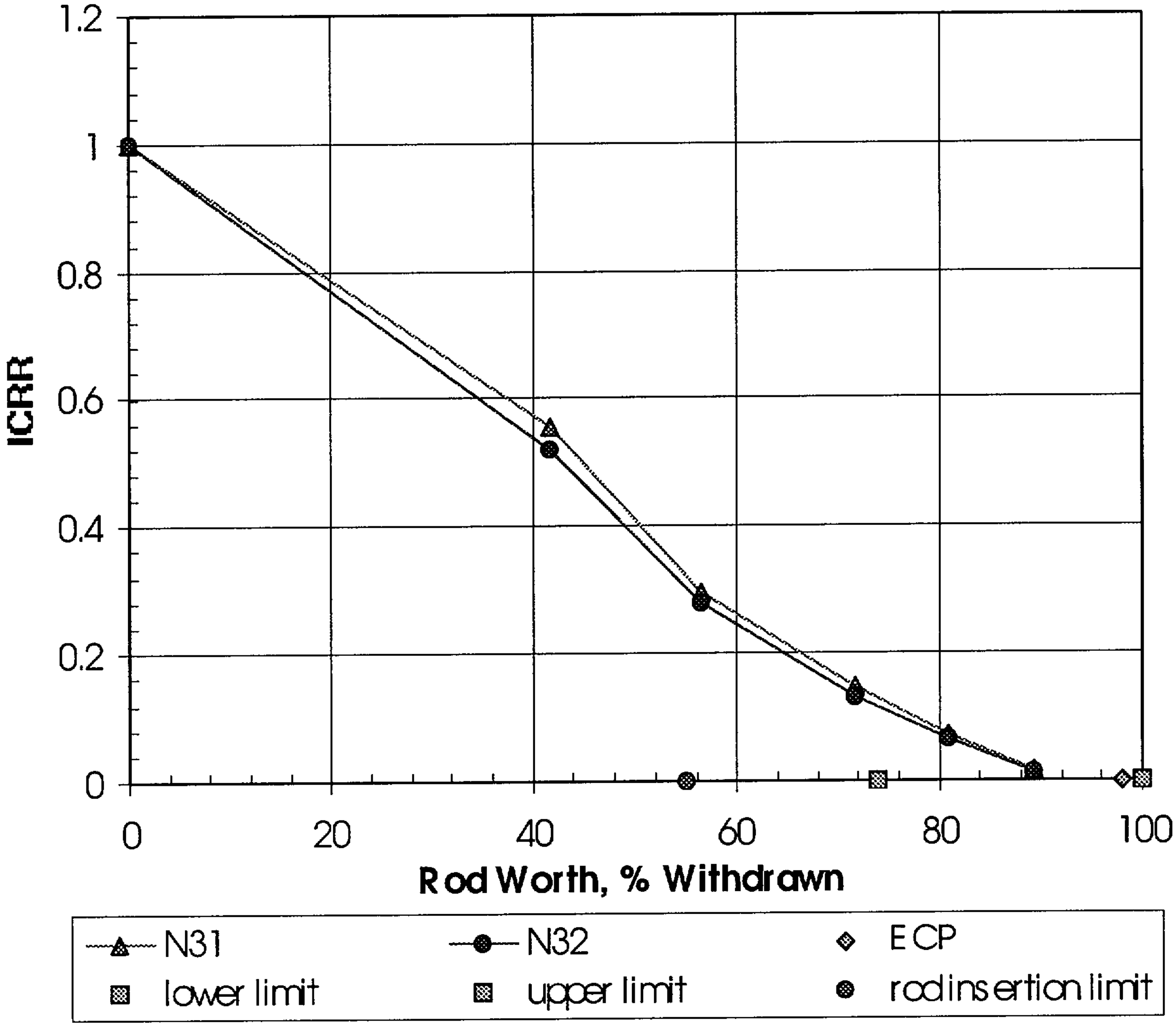
The Estimated Critical Position for C1C13 initial criticality was determined to be Control Bank D at 198 SWD. Rod withdrawal for the approach to criticality began at 0340 with Criticality subsequently achieved at 0420 on November 20, 2000 at a control position of Control Bank D at 172 SWD.

Figure 3 shows the Source Range 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	6.317 × 10^{-7} amps (N41)	N/A
ZPPT Test Limit	5.685 x 10^{-7} amps (N41)	N/A
ARO Critical Boron	1501 ppmB	1481 ± 50 ppmB
ARO ITC	-7.90 pcm/°F	-8.59 ± 2 pcm/°F
ARO MTC	-6.22 pcm/°F	-6.91 pcm/°F
Control Bank D Worth	728.4 pcm	681.4 ± 102.21 pcm
Control Bank C Worth	808.4 pcm	808.6 ± 121.3 pcm
Control Bank B Worth	678.0 pcm	612.6 ± 100 pcm
Control Bank A Worth	328.7 pcm	385.3 ± 100 pcm
Shutdown Bank E Worth	483.2 pcm	473.5 ± 100 pcm
Shutdown Bank D Worth	519.7 pcm	463.7 ± 100 pcm
Shutdown Bank C Worth	511.6 pcm	463.3 ± 100 pcm
Shutdown Bank B Worth	1045.4 pcm	925.3 ± 138.8 pcm
Shutdown Bank A Worth	264.5 pcm	237.1 ± 100 pcm
Total Rod Worth	5367.9 pcm	5050.8 ± 317.1 pcm

FIGURE 3
ICRR vs. CONTROL ROD WITHDRAWAL 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 +40pcm 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 13 on November 20, 2000. Results are summarized in Table 5.

TABLE 5
REACTIVITY COMPUTER CHECKOUT

Period (seconds)	Theoretical Reactivity (pcm)	Measured Reactivity (pcm)	Absolute Error (pcm)	Percent Error (%)
185.3	32.5	31.3	1.2	-3.58

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 13, the Point of Nuclear Heat Addition was determined per PT/0/A/4150/01A, Zero Power Physics Testing, on November 20, 2000. Table 6 summarizes the data obtained.

The Zero Power Physics Test Limit was set at 5.685 x 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
1.14×10^{-6}	6.32×10^{-7}	6.92×10^{-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 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 13 rod worth measurements via DRWM were performed on November 20, 2000 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 Dynamic Rod Worth Measurement. Reactor Coolant System boron samples are obtained at 30 minute intervals during DRWM. The reactivity difference from criticality to the 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 13 beginning of cycle, hot zero power, all rods out, critical boron concentration was measured on November 20, 2000 per PT/0/A/4150/01A, Zero Power Physics Testing. The ARO, HZP boron concentration was measured to be 1501 ppmB. Predicted ARO critical boron concentration was 1481 ppmB. The acceptance criterion (measured boron within 50 ppmB of predicted) was therefore met.

3.6 ARO Isothermal Temperature Coefficient Measurement

The all rods out (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 of ~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 of ~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 13 ITC was measured per PT/0/A/4150/01A, Zero Power Physics Testing, November 20, 2000. 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 –7.90 pcm/°F. Predicted ITC was –8.59 pcm/°F. Measured ITC was therefore within acceptance criterion of predicted ITC ± 2 pcm/°F.

The MTC was determined to be –6.22 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	555.6	-7.79
Heatup	555.6	-8.01
Average	555.6	-7.90

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 ~30%,~74%, and 100% power.

Significant tests performed during C1C13 Power Escalation were:

- Core Power Distribution (at ~30, ~74, and 100% power)
- One-Point Incore/Excore Calibration (at ~30% 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.

Power Escalation Testing for Catawba 1 Cycle 13 began on November 20, 2000. Full power was reached on November 27, 2000. Full power testing was completed on November 29, 2000. 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 13 Core Power Distribution measurements were performed on November 21, 2000 (30% power), November 22, 2000 (74% power), and November 27, 2000 (100% power). Tables 8 through 10 summarize the results. All acceptance criteria were met.

TABLE 8
CORE POWER DISTRIBUTION RESULTS
30% POWER

Plant Data

Map ID:	FCM/1/13/001
Date of Map:	November 21, 2000
Cycle Burnup:	0.126 EFPD
Power Level:	29.412% F.P.
Control Rod Position:	Control Bank D at 216 Steps Wd
Reactor Coolant System Boron Concentration:	1398 ppmB

COMET Results

Core Average Axial Offset:	14.953%
Tilt Ratios for Entire Core Height: Quadrant 1:	1.00676
Quadrant 2:	1.02402 *
Quadrant 3:	0.98740
Quadrant 4:	0.98183
Maximum F_Q (nuclear):	2.120
Maximum $F_{\Delta H}$ (nuclear):	1.578
Maximum Error between Pred. and Meas $F_{\Delta H}$:	11.47%
Average Error between Pred. and Meas. $F_{\Delta H}$:	2.90%
Maximum Error between Expected and Measured Detector Response:	10.88% *
RMS of Errors between Expected and Measured Detector Response:	3.79%
Minimum F_Q Operational Margin:	29.78%
Minimum F_Q RPS Margin:	6.34%
Minimum F_Q Steady State Margin:	52.46%
Minimum $F_{\Delta H}$ Surveillance Margin:	25.80%
Minimum $F_{\Delta H}$ Steady State Margin:	21.75%

* Nuclear Design and Reactor Support (NDRS) reviewed the 30% flux map, with particular attention to these values which challenged the UFSAR section 14.3.3 acceptance criteria for Flux Symmetry check. Based on NDRS recommendations, power ascension continued and the next flux map analyzed at 74%. NDRS evaluation is documented in PT/0/A/4150/005.

TABLE 9
CORE POWER DISTRIBUTION RESULTS
74% POWER

Plant Data

Map ID:	FCM/1/13/002
Date of Map:	November 22, 2000
Cycle Burnup:	0.672 EFPD
Power Level:	74.116% F.P.
Control Rod Position:	Control Bank D at 216 Steps Wd
Reactor Coolant System Boron Concentration:	1162 ppmB

COMET Results

Core Average Axial Offset:	1.356%
Tilt Ratios for Entire Core Height: Quadrant 1:	1.00725
Quadrant 2:	1.01307
Quadrant 3:	0.99082
Quadrant 4:	0.98886
Maximum F_Q (nuclear):	1.831
Maximum $F_{\Delta H}$ (nuclear):	1.511
Maximum Error between Pred. and Meas $F_{\Delta H}$:	6.54%
Average Error between Pred. and Meas. $F_{\Delta H}$:	2.11%
Maximum Error between Expected and Measured Detector Response:	7.04%
RMS of Errors between Expected and Measured Detector Response:	3.11%
Minimum F_Q Operational Margin:	5.22%
Minimum F_Q RPS Margin:	9.72%
Minimum F_Q Steady State Margin:	40.90%
Minimum $F_{\Delta H}$ Surveillance Margin:	22.55%
Minimum $F_{\Delta H}$ Steady State Margin:	20.08%

TABLE 10
CORE POWER DISTRIBUTION RESULTS
100% POWER

Plant Data

Map ID:	FCM/1/13/003
Date of Map:	November 27, 2000
Cycle Burnup:	5.310 EFPD
Power Level:	99.741% F.P.
Control Rod Position:	Control Bank D at 215 Steps Wd
Reactor Coolant System Boron Concentration:	844 ppmB

COMET Results

Core Average Axial Offset:	-3.740%
Tilt Ratios for Entire Core Height: Quadrant 1:	0.99921
Quadrant 2:	1.01571
Quadrant 3:	0.99170
Quadrant 4:	0.99338
Maximum F_Q (nuclear):	1.844
Maximum $F_{\Delta H}$ (nuclear):	1.486
Maximum Error between Pred. and Meas $F_{\Delta H}$:	7.47%
Average Error between Pred. and Meas. $F_{\Delta H}$:	1.51%
Maximum Error between Expected and Measured Detector Response:	7.38%
RMS of Errors between Expected and Measured Detector Response:	2.14%
Minimum F_Q Operational Margin:	2.02%
Minimum F_Q RPS Margin:	12.34%
Minimum F_Q Steady State Margin:	20.61%
Minimum $F_{\Delta H}$ Surveillance Margin:	8.13%
Minimum $F_{\Delta H}$ Steady State Margin:	17.11%

4.2 One-Point Incore/Excore Calibration

PT/0/A/4600/05D, One-Point Incore/Excore Calibration, is performed using results of Power Range NIS data taken during the Low Power Level Flux Map (30% F.P. for C1C13) and the measured incore axial offset. Power Range channels are calibrated before exceeding 50% in order to have valid indications of Axial Flux Difference and Quadrant Power Tilt Ratio for subsequent power ascension. The calibration is checked using the Intermediate Power Level Flux Map (74% F.P. for C1C13). If necessary, Power Range NIS is recalibrated per PT/0/A/4600/05D or PT/0/A/4600/05A, Incore/Excore Calibration.

Data for the Low Power Level calibration was obtained on November 21, 2000 and all Power Range NIS calibrations were completed the same day. Results are presented in Table 11. All acceptance criteria were met.

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

Reactor Power = 29.41% Axial Offset = 14.953%

Measured Power Range Currents, μAmps

	N41	N42	N43	N44
Upper	73.7	73.8	70.2	56.5
Lower	67.3	62.5	62.5	52.3

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

	N41	N42	N43	N44
Upper	0.8337	0.8694	0.8396	0.8429
Lower	0.8817	0.9081	0.8970	0.8930

New Calibration Currents, μAmps

Axial Offset, %	N41		N42		N43		N44	
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
+20	259.7	219.8	259.9	204.1	247.3	204.1	199.1	170.8
0	223.8	255.5	224.4	237.2	213.2	237.6	171.3	198.3
-20	187.8	291.2	188.9	270.3	179.1	271.2	143.5	225.8

Data for the Intermediate Power Level calibration check was obtained at 74% F.P. on November 22, 2000. Since a comparison of Indicated Excore AFD with Measured Incore AFD for all quadrants (obtained from the 74% flux map) fell within the acceptable range of >2.0% (but <3.0%) difference, no One-Point Incore/Excore Calibration was required at that time.

4.3 Reactor Coolant Loop Delta Temperature Measurement

Reactor Coolant System (NC) Hot Leg and Cold Leg temperature data is normally obtained at approximately 75% F.P. and 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 C1C13, the four pre-existing loop ΔT_0's were evaluated at 74% F.P. on November 22, 2000 and found to be unacceptable (present ΔT_0 more than 1.2°F above calculated for three of the four loops). Power ascension was halted while PT/0/A/4600/026 was performed. Power ascension continued to 100% F.P. where the ΔT_0's were re-evaluated. At full power, on November 27, 2000, the Loop 1A and 1B ΔT_0 constants were found to be outside the acceptance criterion (present ΔT_0 within 0.6°F of calculated) and were therefore subsequently adjusted by 7300 Process personnel. Table 13 summarizes the test results.

TABLE 12
REACTOR COOLANT DELTA TEMPERATURE DATA

Reactor Power = 74.1460%

	Loop A	Loop B	Loop C	Loop D
Meas. T_{HOT}, °F	598.1	595.5	599.2	598.1
Meas. T_{COLD}, °F	552.2	552.0	552.1	552.2
Calc. Δh, BTU/lb	60.658	57.139	62.356	60.690
Calc. Δh_0, BTU/lb	82.809	77.063	84.099	81.852
Calc. ΔT_0, °F	59.7	56.6	61.2	59.7
Current ΔT_0, °F	61.1	57.9	62.7	58.5
Difference, °F	**-1.4**	**-1.3**	**-1.5**	1.2

Reactor Power = 99.8388%

	Loop A	Loop B	Loop C	Loop D
Meas. T_{HOT}, °F	614.6	611.5	615.9	614.0
Meas. T_{COLD}, °F	554.3	554.1	554.1	554.5
Calc. Δh, BTU/lb	82.269	77.777	84.308	80.998
Calc. Δh_0, BTU/lb	82.402	77.902	84.444	82.128
Calc. ΔT_0, °F	60.5	57.5	61.8	59.6
Current ΔT_0, °F	59.7	56.6	61.2	59.7
Difference, °F	**0.8**	**0.9**	0.6	-0.1

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 13, the Hot Full Power critical boron concentration was measured on November 26, 2000. The measured HFP, ARO critical boron concentration was 854 ppmB. Predicted HFP critical boron concentration was 811 ppmB. The ARO Boron Endpoint Measurement during ZPPT yielded a measured HZP Boron Concentration of 1493 ppmB (prediction being 1481 ppmB). The Predicted ΔBoron was therefore 670 ppmB, while the Measured ΔBoron was 639 ppmB. The difference of 31 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 Power Range 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 13 on November 27, 28 and 29, 2000. All Power Range NIS calibrations were completed on November 29. Eight flux maps, with axial offsets ranging from -12.921% to 1.880% 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%	293.9	234.6	287.3	212.8	272.7	213.3	222.9	180.2
0%	255.5	276.9	249.6	250.8	238.8	253.6	193.7	213.1
-20%	217.1	319.2	211.9	288.8	204.9	293.9	164.5	246.0

Correction (M_J) Factors

N41	N42	N43	N44
1.320	1.322	1.330	1.310

4.6 Calorimetric Reactor Coolant Flow Measurement

With clean 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 C1C13, are summarized in Table 14. All acceptance criteria were met.

TABLE 14
CALORIMETRIC REACTOR COOLANT FLOW MEASUREMENT

Run Number	Total Calculated Reactor Coolant Flow (GPM)	Calculated Thermal Power Level (%)
1	395445	99.648
2	395429	99.616
3	395209	99.641
Average	395361	99.635