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February 16, 2012

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

Subject: Duke Energy Carolinas, LLC
Oconee Nuclear Station, Unit 2
Docket Number 50-270
Unit 2 Cycle 26 Startup Testing Report

Pursuant to the requirements in Section 16.13.9, "Startup Report," from the Selected Licensee Commitments Manual, Duke Energy Carolinas, LLC hereby submits to the Nuclear Regulatory Commission (NRC) the Oconee Nuclear Station Unit 2, Cycle 26 (O2C26) Startup Testing Report. The premise of the report is to provide the Staff with the satisfactory results from the O2C26 startup tests that incorporates the stations' first 24-month cycle, full core loading of AREVA Mark B-HTP fuel, and first cycle to contain fuel with Gadolinia in batch quantities.

If you have any questions or require additional information, please contact Kent Alter, Oconee Regulatory Compliance Group, at (864) 873-3255.

This letter and its attachment do not contain NRC commitments.

Sincerely,

TPGillespie
T. Preston Gillespie, Jr.
Vice President
Oconee Nuclear Station

Attachment

IE26

cc: (w/attachment)

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DUKE ENERGY CAROLINAS, LLC

OCONEE NUCLEAR STATION

OCONEE 2 CYCLE 26 (O2C26)

STARTUP TESTING REPORT

Part 1: Fuel and Core Design

Part 2: Zero Power Physics Test

Part 3: Power Escalation Test

Prepared by: Nicolas Hernandez
Date: February 9, 2012

OCONEE 2 CYCLE 26
Startup Testing Report
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Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design

1.0 Summary

The Unit 2 Cycle 26 (O2C26) core consists of 177 Mk B-HTP fuel assemblies, each of which is a 15 by 15 array containing 208 fuel rods, 16 guide tubes and one incore instrument guide tube. The fuel consists of dished-end, cylindrical pellets of uranium dioxide. Both the reinserted fuel and fresh fuel are clad in M5 and have M5 guide tubes. The O2C26 fuel assemblies have nominal fuel loading of 490 kg uranium, with minor reductions in batches with Gadolinium content. The fresh fuel is not radially enrichment zoned.

The O2C26 core loading for this cycle consists of the following:

32 fresh Mk B-HTP fuel assemblies with 4.33 wt% U-235 (designated Batch 28A).

40 fresh Mk B-HTP fuel assemblies with 4.53 wt% U-235 each with various Gadolinia (Gad) loadings and layouts (designated Batches 28B, 28C, 28D, 28E). Description of the Gadolinia assemblies is provided in figures 2 – 7.

32 reinserted Mk B-HTP fuel assemblies with 3.76 wt% U-235 each containing 16 radially zoned reduced enrichment fuel pins at 3.46 wt% U-235 (designated Batch 27A)

36 reinserted Mk B-HTP fuel assemblies with 4.16 wt% U-235 each containing 16 radially zoned reduced enrichment fuel pins at 3.86 wt% U-235 (designated Batch 27B)

37 reinserted Mk B-HTP fuel assemblies with 3.33 wt% U-235 each containing 16 radial zoned reduced enrichment fuel pins at 3.03 wt% U-235 (designated Batch 26C)

Figure 1 shows the batch loading pattern.

All non-Gad pins have 6.05 inch blanket regions (top and bottom) enriched to 2.50 wt% U-235. All Gad pins have 9.9 inch blanket regions (top and bottom) enriched to 2.50 wt% U-235. The core periphery is composed of Batch 27A and 26C assemblies. All batches of fuel assemblies are distributed throughout the core interior including a Batch 26C fuel assembly that is located in the center of the core. No fuel assemblies or burnable poison rods from the spent fuel pool are being used in O2C26.

Cycle 26 will operate in a rods-out, feed and bleed mode. Core reactivity control is supplied mainly by soluble boron and is supplemented by 61 full length Ag-In-Cd control rods, Gadolinia which is incorporated into some of the fuel pellets, & 40 burnable poison rod assemblies (BPRAs). In addition to the full length control rods, eight Inconel (gray) axial shaping rods (APSRs) are provided for additional control of the axial power distribution.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design

Oconee 2 Cycle 26 is the first 24 Month Cycle at Oconee. It also is the first full core at Oconee made up entirely of Mk-B-HTP fuel and the first Oconee cycle to contain fuel with Gadolinia in batch quantities. Twenty-four (24) Month Cycle designs allow the three-unit Oconee site to reduce refueling outages by one every other year, resulting in a significant cost savings.

Twenty-four (24) Month Cycle designs generally require more feed assemblies than 18 month designs. To design an efficient 24 Month Cycle, Gadolinia integral burnable absorber is necessary to allow feed fuel assemblies to reside in control rod locations. This allows movement of the feed fuel away from the core periphery and reduces the cycle leakage. To obtain more accurate calculation results for Gadolinia, the CASMO-3 code was upgraded to the newer version CASMO-4. License Amendment Requests (LARs) for the transition to Gadolinia and CASMO-4 were submitted, and both were approved prior to cycle startup. The ability to operate the cycle for its full 24 month design life is dependent upon NRC approval of an LAR currently under their review.

Twenty-four (24) Month Cycles with Gadolinia and CASMO-4 code methods are scheduled for all three Oconee Units.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design
Figure 1: O2C26 Final Core Load Map

Figure 1
Oconee 2 Cycle 26
Final Core Load Map

(X) above column 8; (W) left of row H; (Y) right of row H; (Z) below column 8.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A						NJ0ALE 26C	NJ0ALK 26C	NJ0DG5 27A	NJ0AM0 26C	NJ0AKK 26C					
B				NJ0ALW 26C	NJ0AM5 26C	UDNA35 C29R 28B	UDNA58 28D	NJ0DHH C2F7 27B	UDNA60 28D	UDNA38 C2GE 28B	NJ0AKH 26C	NJ0AM9 26C			
C			NJ0AL1 26C	UDNA40 28B	UDNA66 C33H 28E	UDNA50 BF1W 28C	NJ0DH0 C2FA 27A	UDNA03 BF10 28A	NJ0DH5 C2FC 27A	UDNA52 BF1Y 28C	UDNA68 C33J 28E	UDNA46 28B	NJ0AL2 26C		
D		NJ0AK6 26C	UDNA47 28B	NJ0DJ0 C2DD 27B	NJ0DJH 27B	NJ0DH6 A08H 27B	UDNA10 BF1L 28A	NJ0DG1 C2DE 27A	UDNA13 BF1N 28A	NJ0DHN A08A 27B	NJ0DHP 27B	NJ0DJ9 C2DF 27B	UDNA34 28B	NJ0ALM 26C	
E		NJ0ALC 26C	UDNA69 C33K 28E	NJ0DHG 27B	NJ0DGN C2FD 27A	UDNA23 BF15 28A	NJ0DHJ C2BN 27B	NJ0DHX 27B	NJ0DJ3 C2BT 27B	UDNA24 BF17 28A	NJ0DGG C2FE 27A	NJ0DHM 27B	UDNA70 C33L 28E	NJ0ALH 26C	
F	NJ0AM3 26C	UDNA48 C335 28B	UDNA53 BF20 28C	NJ0DHR A08G 27B	UDNA02 BF1E 28A	NJ0DGJ C2F8 27A	UDNA31 BF1F 28A	NJ0DH3 C2D5 27A	UDNA05 BF0Y 28A	NJ0DG6 C2FN 27A	UDNA18 BF1J 28A	NJ0DJE A08J 27B	UDNA54 BF21 28C	UDNA36 C336 28B	NJ0AKX 26C
G	NJ0ALA 26C	UDNA61 28D	NJ0DG3 C2FF 27A	UDNA19 BF1P 28A	NJ0DHC C2BU 27B	UDNA15 BF11 28A	NJ0DGW C2D6 27A	UDNA16 BF0T 28A	NJ0DGK C2D7 27A	UDNA09 BF1A 28A	NJ0DJJ C2BV 27B	UDNA12 BF1R 28A	NJ0DH4 C2FG 27A	UDNA62 28D	NJ0AKP 26C
(W) H	NJ0DGT 27A	NJ0DJC C2FP 27B	UDNA01 BF1C 28A	NJ0DH2 C2DG 27A	NJ0DHW 27B	NJ0DGV C2D8 27A	UDNA22 BF0U 28A	NJ0ALJ C339 26C	UDNA08 BF0V 28A	NJ0DG2 C2D9 27A	NJ0DHK 27B	NJ0DGD C2DH 27A	UDNA07 BF18 28A	NJ0DJ5 C2FR 27B	NJ0DGC 27A (Y)
K	NJ0ALR 26C	UDNA63 28D	NJ0DG4 C2FH 27A	UDNA29 BF1T 28A	NJ0DHA C2D1 27B	UDNA27 BF19 28A	NJ0DGL C2DA 27A	UDNA21 BF0W 28A	NJ0DGE C2DC 27A	UDNA32 BF14 28A	NJ0DHL C2D2 27B	UDNA20 BF1K 28A	NJ0DGX C2FJ 27A	UDNA57 28D	NJ0AK9 26C
L	NJ0ALN 26C	UDNA43 C33A 28B	UDNA55 BF22 28C	NJ0DJ4 A08F 27B	UDNA17 BF16 28A	NJ0DGR C2FT 27A	UDNA26 BF0X 28A	NJ0DG0 C2FM 27A	UDNA06 BF1D 28A	NJ0DGP C2FU 27A	UDNA30 BF13 28A	NJ0DH9 A08D 27B	UDNA49 BF1V 28C	UDNA44 C33C 28B	NJ0AM4 26C
M		NJ0ALP 26C	UDNA71 C33M 28E	NJ0DHE 27B	NJ0DGA C2FK 27A	UDNA04 BF12 28A	NJ0DJ2 C2D3 27B	NJ0DHD 27B	NJ0DJA C2D4 27B	UDNA11 BF1H 28A	NJ0DGM C2FL 27A	NJ0DHT 27B	UDNA65 C33N 28E	NJ0AL5 26C	
N		NJ0AKD 26C	UDNA41 28B	NJ0DHV C2DJ 27B	NJ0DJK 27B	NJ0DJ1 A08E 27B	UDNA25 BF1U 28A	NJ0DH1 C2DK 27A	UDNA14 BF1M 28A	NJ0DJL A08C 27B	NJ0DJ6 27B	NJ0DJG C2DL 27B	UDNA42 28B	NJ0AKT 26C	
O			NJ0ALG 26C	UDNA37 28B	UDNA72 C33P 28E	UDNA56 BF23 28C	NJ0DGH C334 27A	UDNA28 BF1G 28A	NJ0DG9 C33G 27A	UDNA51 BF1X 28C	UDNA67 C33R 28E	UDNA39 28B	NJ0AKE 26C		
P				NJ0AL9 26C	NJ0AL3 26C	UDNA33 C33D 28B	UDNA64 28D	NJ0DJD C2FV 27B	UDNA59 28D	UDNA45 C33E 28B	NJ0AKW 26C	NJ0AM1 26C			
R						NJ0ALD 26C	NJ0AM6 26C	NJ0DEX 27A	NJ0ALT 26C	NJ0AL6 26C					

Legend (box):
Fuel ID
Control Component ID & Type (A = APSR, B = BPRA**, C = CRA); (italics indicate reinsert BPRA)
Fuel Batch

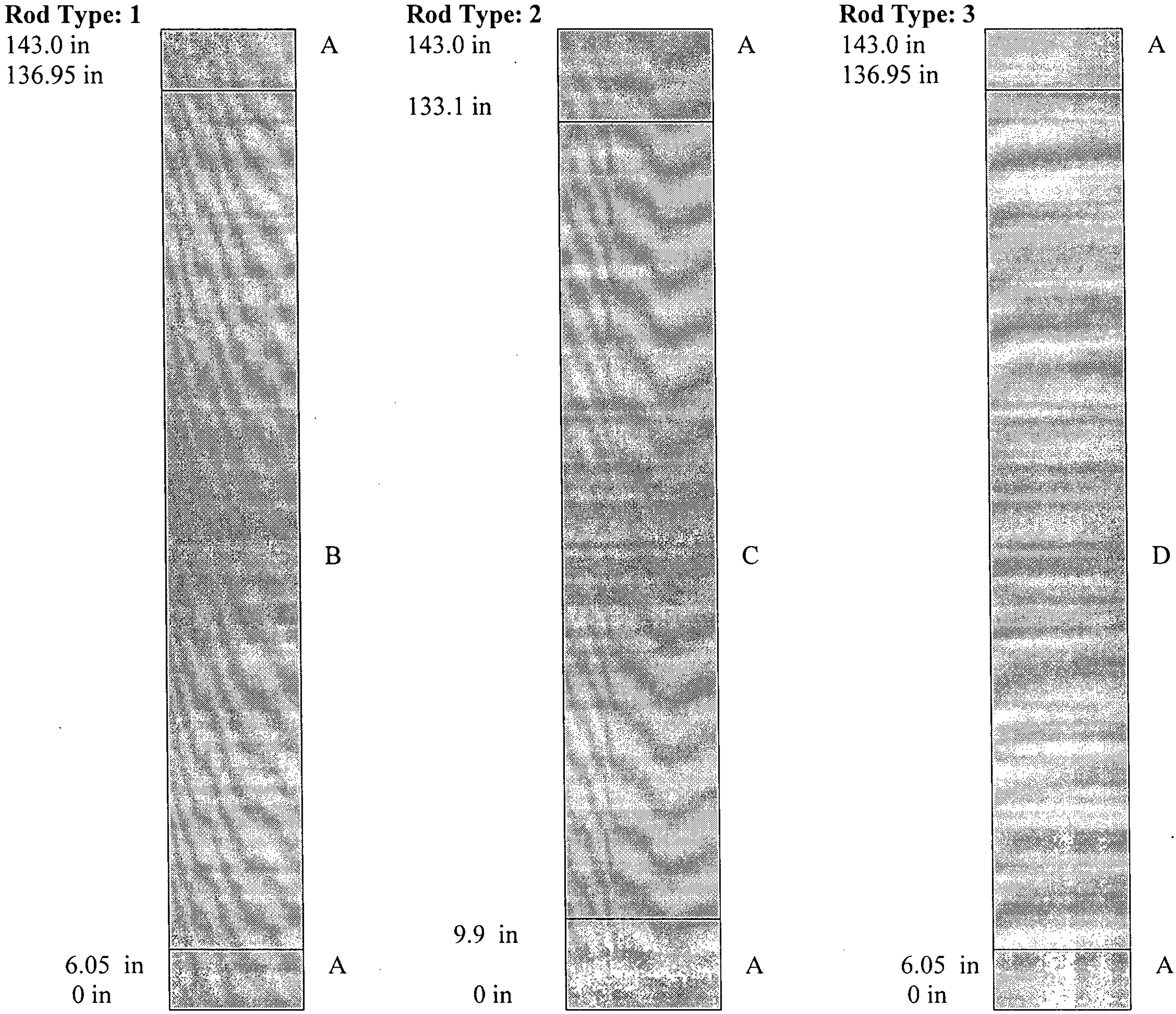
Note: All fuel batches are Mk-B-HTP fuel assemblies.

** All BPRAs are Mk-B5:

```
BF0T - BF0W - 2.50 wt% B4C BPRA
BF0X - BF1J - 3.00 wt% B4C BPRA
BF1K - BF23 - 3.50 wt% B4C BPRA
```

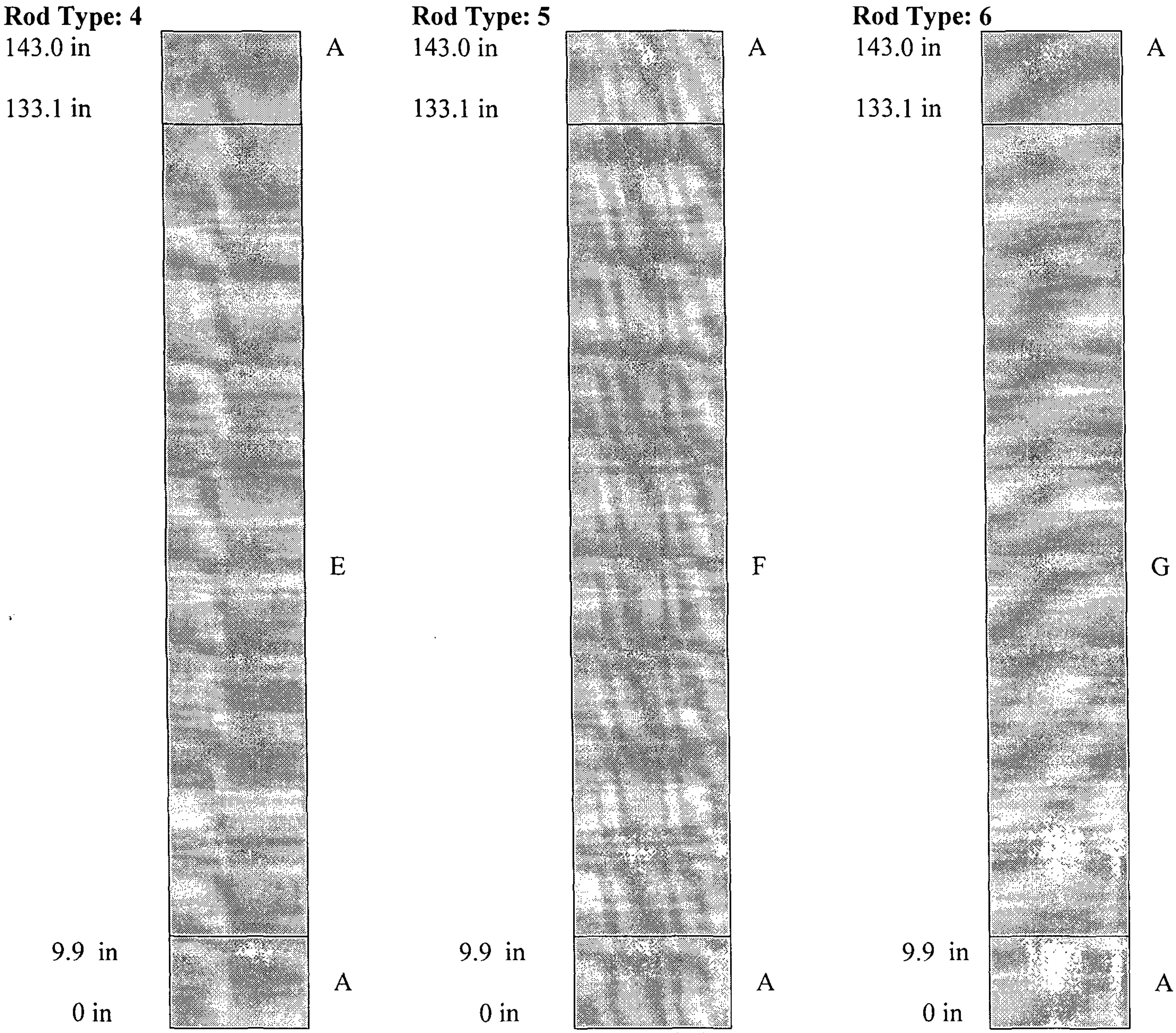
Note: Fresh fuel assemblies are shaded. All other fuel assemblies are from O2C25.

Figure 2: Rod Type Axial Profiles with Enrichment Table for Oconee 2 Batch 28



Axial Zone Index	Axial Zone Enrichment	Gad w/o
A	2.50 (Blanket)	0.0
B	4.33 (Primary)	0.0
C	3.46 (Gd Carrier)	4.0
D	4.53 (Primary)	0.0
E	3.62 (Gd Carrier)	4.0
F	3.85 (Gd Carrier)	3.0
G	2.72 (Gd Carrier)	8.0

Figure 2: Rod Type Axial Profiles with Enrichment Table for Oconee 2 Batch 28 (Continued)



Axial Zone Index	Axial Zone Enrichment	Gad w/o
A	2.50 (Blanket)	0.0
B	4.33 (Primary)	0.0
C	3.46 (Gd Carrier)	4.0
D	4.53 (Primary)	0.0
E	3.62 (Gd Carrier)	4.0
F	3.85 (Gd Carrier)	3.0
G	2.72 (Gd Carrier)	8.0

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design
Figure 3: Oconee 2 Cycle 26 Rod Type Map, Batch 28A

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	2	1	1	1	1	1	1	1	1	1	1	1	2	1
1	1	1	1	1		1	1	1		1	1	1	1	1
1	1	1		1	1	1	1	1	1	1		1	1	1
1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
1	1		1	1		1	1	1		1	1		1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	2	1	1		1	1	2	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1		1	1		1	1	1		1	1		1	1
1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
1	1	1		1	1	1	1	1	1	1		1	1	1
1	1	1	1	1		1	1	1		1	1	1	1	1
1	2	1	1	1	1	1	1	1	1	1	1	1	2	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

"BPRA" rod (2.5, 3.0 or 3.5 w/o B_4C)

Note: Rod type numbers are defined in Figure 2.

Figure 4: Oconee 2 Cycle 26 Rod Type Map, Batch 28B

3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	5	3	3	3	3	3	3	3	3	3	3	3	5	3
3	3	3	3	3	○	3	3	3	○	3	3	3	3	3
3	3	3	○	3	3	3	3	3	3	3	○	3	3	3
3	3	3	3	3	3	3	5	3	3	3	3	3	3	3
3	3	○	3	3	○	3	3	3	○	3	3	○	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	5	3	3		3	3	5	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	○	3	3	○	3	3	3	○	3	3	○	3	3
3	3	3	3	3	3	3	5	3	3	3	3	3	3	3
3	3	3	○	3	3	3	3	3	3	3	○	3	3	3
3	3	3	3	3	○	3	3	3	○	3	3	3	3	3
3	5	3	3	3	3	3	3	3	3	3	3	3	5	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

○ NO BPRA

Note: Rod type numbers are defined in Figure 2.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design
Figure 5: Oconee 2 Cycle 26 Rod Type Map, Batch 28C

3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	4	3	3	3	3	3	3	3	3	3	3	3	4	3
3	3	3	3	3	⊜	3	3	3	⊜	3	3	3	3	3
3	3	3	⊜	3	3	3	3	3	3	3	⊜	3	3	3
3	3	3	3	3	3	3	4	3	3	3	3	3	3	3
3	3	⊜	3	3	⊜	3	3	3	⊜	3	3	⊜	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	4	3	3		3	3	4	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	⊜	3	3	⊜	3	3	3	⊜	3	3	⊜	3	3
3	3	3	3	3	3	3	4	3	3	3	3	3	3	3
3	3	3	⊜	3	3	3	3	3	3	3	⊜	3	3	3
3	3	3	3	3	⊜	3	3	3	⊜	3	3	3	3	3
3	4	3	3	3	3	3	3	3	3	3	3	3	4	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

⊜ "BPRA" rod (3.5 w/o B_4C)

Note: Rod type numbers are defined in Figure 2.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design
Figure 6: Oconee 2 Cycle 26 Rod Type Map, Batch 28D

3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	4	3	3	○	3	3	3	○	3	3	4	3	3
3	3	3	○	3	3	3	4	3	3	3	○	3	3	3
3	3	3	3	4	3	3	3	3	3	4	3	3	3	3
3	3	○	3	3	○	3	3	3	○	3	3	○	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	4	3	3	3		3	3	3	4	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	○	3	3	○	3	3	3	○	3	3	○	3	3
3	3	3	3	4	3	3	3	3	3	4	3	3	3	3
3	3	3	○	3	3	3	4	3	3	3	○	3	3	3
3	3	4	3	3	○	3	3	3	○	3	3	4	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

○ NO BPRA

Note: Rod type numbers are defined in Figure 2.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 1: Fuel and Core Design
Figure 7: Oconee 2 Cycle 26 Rod Type Map, Batch 28E

3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	4	3	3	4	3	3	3	3	3	4	3	3	4	3
3	3	3	3	3	○	3	3	3	○	3	3	3	3	3
3	3	3	○	3	3	3	3	3	3	3	○	3	3	3
3	4	3	3	6	3	3	6	3	3	6	3	3	4	3
3	3	○	3	3	○	3	3	3	○	3	3	○	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	6	3	3		3	3	6	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	○	3	3	○	3	3	3	○	3	3	○	3	3
3	4	3	3	6	3	3	6	3	3	6	3	3	4	3
3	3	3	○	3	3	3	3	3	3	3	○	3	3	3
3	3	3	3	3	○	3	3	3	○	3	3	3	3	3
3	4	3	3	4	3	3	3	3	3	4	3	3	4	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

○ NO BPRA

Note: Rod type numbers are defined in Figure 2.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 2: Zero Power Physics Test

2.0 Introduction and Summary

The Oconee 2 Cycle 26 Zero Power Physics Test (ZPPT) was conducted from November 16 through 17, 2011, per station procedure PT/0/A/0711/001 (title?). This testing was conducted to verify the nuclear parameters upon which the Oconee 2 Cycle 26 core design, safety analysis and Technical Specifications are based.

Zero Power Physics Testing measurements were made with reactor power, Reactor Coolant System (RCS) pressure and RCS temperature as required by procedure. The following nuclear parameters were measured:

(a) All-Rods-Out Critical Boron Concentration (Enclosure 1.0)

(b) Differential Boron Worth (Enclosure 1.0)

(c) Integral Rod Worth for Control Rod Groups 6 and 7 (Enclosure 2.0)

(d) Temperature and Moderator Coefficients of Reactivity (Enclosure 3.0)

The AREVA Reactivity Measurement and Analysis System (RMAS) was used to record Reactor Coolant System (RCS) temperature, wide range power levels and control rod positions. Reactivity was calculated by the RMAS computer.

On November 17th, 2011 at 23:22, ZPPT was declared complete. All acceptance criteria were met.

2.1 Approach to Criticality

The full RCS temperature and pressure necessary for unit startup were achieved and rod withdrawal for the Control Rod Drive Trip Time Test (CRDTTT) began at 21:31 on November 16th, 2011. The CRDTTT was performed at Mode 3, hot standby conditions (>250°F and > 1% Δk/k shutdown) per station procedure PT/0/A/0300/001. Each control rod group was individually withdrawn. The CRDTTT was satisfactorily completed at 00:15 on November 17, 2011.

Rod withdrawal for approach to criticality began on November 17, 2011 at 08:07. The estimated critical position was calculated to be Group 7 at 77% per station procedure PT/2/A/1103/015. Criticality was achieved at 13:11 on November 17, 2011 with rod Groups 1-6 at 100% wd (withdrawn), Group 7 at 79.41% wd, Group 8 at 35% wd, an RCS average temperature of 532 °F, and an RCS boron concentration of 1952 ppmB.

2.2 Pre-Physics Measurements

After establishing stable conditions with the reactor critical, reactor power was slowly increased to perform the reactimeter checkout and approach the Point Of Adding sensible Heat (POAH). The POAH was found to be 0.123% FP. From the sensible heat determination, the upper testing limit on the wide range NIs (as indicated on the Control Room Chart Recorder) was established for ZPPT.

An on-line OAC reactimeter checkout was performed for both a positive and negative power ramp. The positive ramp involved a reactivity change of +530 μρ and the measured doubling times were within 1.34% of the predicted doubling times. The negative ramp involved a reactivity change of about -281 μρ and the measured doubling times were within 1.20% of the predicted doubling times. The measured doubling times were well within the ±5% acceptance criteria for the positive ramp and the ±7% acceptance criteria for the negative ramp.

2.3 Physics Testing

A. Essentially All Rods Out (EARO) Boron Concentration Measurement

The RCS EARO boron concentration was calculated starting from a configuration of Groups 1-6 at 100% wd, Group 7 at 76.7% wd, and APSR Group 8 at 35% wd. The control rods were moved to their essentially all rods out position (Groups 1-6 at 100% wd, Group 7 at 80%, Group 8 at 35% wd) and the associated reactivity change was converted to a boron equivalent in ppmB. The all rods out boron concentration was then calculated and verified to be within procedure acceptance criteria. Refer to Enclosure 1.0 for more detailed results.

B. Reactivity Coefficient Measurements

The temperature coefficient measurement was made while maintaining equilibrium boron concentration in the RCS, with control rod Group 7 withdrawn to 76.6% wd and with APSR Group 8 at 35% wd. This test measured the reactivity change associated with a ramp increase in RCS temperature of approximately 3.22 °F and a subsequent decrease of 3.56 °F. The data from the two temperature ramps was averaged using the ΔT magnitudes as weighting factors. The change in reactivity was divided by the change in RCS temperature to calculate the temperature coefficient. The measured temperature coefficient was corrected for the difference in RCS average test temperature and reference temperature (532 °F). The moderator temperature coefficient was calculated by subtracting the predicted Doppler coefficient from the measured isothermal temperature coefficient. The isothermal and moderator temperature coefficient were verified to be within the procedure acceptance criteria. Refer to Enclosure 3.0 for more detailed results.

C. Control Rod Integral Worths and Differential Boron Worth Measurement

The worth of Group 7 from 76.6 to 80% wd was measured during the EARO test. The remaining worth of Group 7 and all of Group 6 was measured by steadily deborating the RCS and compensating for the resulting positive reactivity addition by inserting control rods from 76.6% wd on Group 7 to 0% wd on Group 6 (with no rod overlap). The reactivity changes resulting from the discrete control rod insertions were summed for each group to obtain the group integral rod worth. Each of the measured groups passed their individual acceptance criteria and total rod worth (group 7's worth and group 6's worth added together) passed its acceptance criteria. Refer to Enclosure 2.0 for more detailed results.

The differential boron worth was calculated by dividing the rod worths of the measured groups inserted between the initial and final boron samples by the corresponding change in RCS boron concentration. The initial value for the boron concentration was recorded at EARO critical equilibrium conditions. The final value of boron concentration was recorded as reactivity approached steady-state. The measured differential boron worth met procedure acceptance criteria. Refer to Enclosure 1.0 for more detailed results.

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Part 3: Power Escalation Test

3.0 Introduction and Summary

The Oconee 2 Cycle 26 Power Escalation Test was performed between November 18, 2011 and November 21, 2011 per station procedure PT/0/A/0811/001. Testing was performed at ~20% Full Power (FP), 40% FP, 50% FP, 73% FP and 100% FP to verify nuclear parameters upon which the Oconee 2 Cycle 26 core design, safety analysis and Technical Specifications are based. The following tests and verifications were performed:

(a) Initial Core Symmetry Check at 20% FP (Enclosure 7.0);

(b) NSSS Heat Balance at 20% FP, 73% FP, and 100% FP (Enclosure 4.0);

(c) Incore Detector Checkout at 11% FP, 40% FP, and 100%FP;

(d) Power Imbalance Detector Correlation Slope Measurement at 73% FP;

(e) Core Power Distribution at 50% FP, and 100% FP (Enclosures 5.0 through 5.3 and 6.0);

(f) All-Rods-Out Critical Boron Concentration at 100% FP (Enclosure 1.0).

The unit reached the Low Power Testing (LPT) plateau at 01:14 on November 18, 2011. Testing at the LPT plateau was completed at 00:57 on 11/19/11. The unit reached the Intermediate Power Testing (IMPT) plateau at 17:28 on 11/19/11. Testing at the IMPT plateau was completed at 01:00 on 11/20/11. The unit reached the Full Power Testing (FPT) plateau at 14:06 on 11/20/11. Full Power Testing (FPT), consisting of Incore Detector Checkout, Core Power Distribution, NSSS Heat Balance, All-Rods-Out Critical Boron, RCS Flow Calculation/Calibration, and update of the RPS RCS Reference Flow was performed at this plateau. FPT was concluded at 12:00 on 11/21/11. Power Escalation Testing was declared complete at 12:00 on 11/21/11.

3.1 NSSS Heat Balance/RCS Flow Verification

Off-line (non-OAC) secondary heat balance calculations were performed at 20% FP, 73% FP and 100% FP. An off-line primary heat balance was performed at 100% FP. These tests verified the accuracy of the on-line primary and secondary-side heat balance calculations. On-line calculations are another term for calculations performed by the OAC (operator aid computer) or plant computer program. The plant on-line computer accuracy was verified by performing an off-line calculation using the same inputs that feed the on-line computer. The on-line and off-line results were compared for the same period, and verified to agree within 2% FP. This same method was used to verify that RCS flow was

greater than the required flow per the Core Operating Limits Report (COLR). Normalization of the plant computer RCS flow constants (used to calculate flow from the primary delta-P instrumentation) was performed during FPT and the on-line power calculations were then verified to agree within 2% FP. Refer to Enclosure 4.0 for more detailed results.

3.2 Initial Core Symmetry Check and Core Power Distribution

Initial Core Symmetry Check was conducted at 20%. Core Power Distribution tests were conducted at 50% FP and at 100% FP. These tests verified that reactor power imbalance, quadrant power tilt and radial/total power peaks did not exceed their respective specified limits.

Specific checks were made as follows:

> Incore imbalance was compared to the error adjusted imbalance LOCA limit curve and was verified to be within specified limits (based on Core Operating Limits Report).
>
> The maximum positive quadrant power tilt was verified to be less than the error adjusted Core Operating Limits Report limit.

As a prerequisite to performing these tests, PT/0/A/0302/006 (Review and Control of Incore Instrumentation Signals) was performed at 11% FP, 40% FP and 100% FP to identify and evaluate erroneous Self Powered Neutron Detector signals.

The results of the initial core symmetry check which occurred at 20% FP can be found in Enclosure 7.0. It can be seen quite clearly that all core symmetric location power comparison deviations are less than 8% and therefore no further evaluation was needed.

The core power distribution tests measure and compare the predicted values of radial and total peaking factors at 50% FP and 100% FP. All acceptance criteria were satisfied. Refer to Enclosures 5.0 - 5.3 along with Enclosure 6.0 for more detailed results.

3.3 Power Imbalance Detector Correlation

The Power Imbalance Detector Correlation was performed at 73% FP. The purpose of this test was to measure the excore to incore power imbalance correlation slopes for NI Channels 5, 6, 7, and 8, and to verify these slopes met acceptance criteria.

The excore/incore imbalance correlation slope for each NI Channel (5-8) was determined by a least squares fit of excore to incore imbalance indications. A total of 19 incore

imbalance points which ranged between –9.90% and +4.08% FP were used. All the slopes were verified to meet acceptance criteria.

3.4 All Rods Out Critical Boron Measurement at Power

The All Rods Out Critical Boron at Power measurement was made at 100% FP, and the difference between measured and predicted reactivity (in terms of ppmB) was verified to be acceptable. Refer to Enclosure 1.0 for more detailed results.

ALL-RODS-OUT CRITICAL BORON CONCENTRATION
AND DIFFERENTIAL BORON WORTH RESULTS

	Zero Power ARO Critical Boron Concentration	**At-Power ARO Critical Boron Concentration**	**Differential Boron Worth**
CONDITIONS	Initial Critical 0 EFPD Gp 7 @ 76.7% wd Gp 8 @ 35% wd 1952 ppmB @ EARO	100% FP 1.3 EFPD Gp 7 @ 87.7% wd Gp 8 @ 35% wd 1444 ppmB	**Initial State:** Gp 7 @ 77% wd Gp 8 @ 35% wd 1952 ppmB **Final State:** Gp 4 @ 100% wd Gp 5 @ 78% wd Gp 8 @ 35% wd 1699 ppmB
MEASURED VALUE	1977 ppmB @ ARO	1391 ppmB	-0.00669 $\%^{\Delta k}/_{k\ ppmB}$
PREDICTED VALUE	1974 ppmB @ ARO	1398 ppmB	-0.00665 $\%^{\Delta k}/_{k\ ppmB}$
DEVIATION	-3 ppmB	-7 ppmB	-0.67%*
ACCEPTANCE CRITERIA	Predicted ± 50 ppmB	Predicted ± 50 ppmB	±15% dev. from predicted

* $\frac{(\text{Predicted} - \text{Measured}) * 100}{\text{Measured}}$

INTEGRAL GROUP ROD WORTH MEASUREMENTS

PARAMETER	MEASURED VALUE (%Δk/k)	PREDICTED VALUE (%Δk/k)	DEVIATION* (%)	ACCEPTANCE CRITERION
Gp 7 Integral Worth	-0.9140	-0.8930	-2.3	± 15% Deviation
Gp 6 Integral Worth	-0.8223	-0.9140	+11.1	± 15% Deviation
Gp 6&7 Integral Worth	-1.7364	-1.8070	+4.1	± 10% Deviation

* % Dev. = $\frac{\text{Predicted - Measured}}{\text{Measured}} * 100$

REACTIVITY COEFFICIENTS

PARAMETER	CONDITIONS	MEASURED VALUE	PREDICTED VALUE	DEVIATION (Meas-Pred)	ACCEPTANCE CRITERIA
Hot Zero Power Temperature Coefficient (ARO)	T_{ave}=534.1 F Gp 7 @ 76.6% wd Gp 8 @ 35% wd 1952 ppmB	-0.15373 E-4 $\frac{\Delta k}{k\ ^{o}F}$	-0.16140 E-4 $\frac{\Delta k}{k\ ^{o}F}$	+0.00767 E-4 $\frac{\Delta k}{k\ ^{o}F}$	Measured -Predicted = $\pm$0.2E-4 $\frac{\Delta k}{k\ ^{o}F}$
Hot Zero Power Moderator Temperature Coefficient (ARO)	T_{ave}=534.1 F Gp 7 @ 76.6% wd Gp 8 @ 35% wd 1952 ppmB	+0.01090 E-4 $\frac{\Delta k}{k\ ^{o}F}$	+0.00323 E-4 $\frac{\Delta k}{k\ ^{o}F}$	+0.00767 E-4 $\frac{\Delta k}{k\ ^{o}F}$	Measured - Predicted = $\pm$0.2E-4 $\frac{\Delta k}{k\ ^{o}F}$ and Measured $\leq$+0.5E-4 $\frac{\Delta k}{k\ ^{o}F}$

NSSS HEAT BALANCE/RCS FLOW VERIFICATION

Test Plateau	Plant Computer Online Primary Power Level (%FP)	Plant Computer Online Sec. Power Level (%FP)	Offline[1] Calculated Primary Power Level	Offline[1] Calculated Secondary Power Level	RCS Flow [1, 2] (%DF)
LPT	19.98	20.39	19.96	20.31	113.60
IMPT	72.26	72.92	72.32	72.84	112.85
FPT	99.87	99.97	99.92	99.88	112.42

[1]Calculated by the online plant computer
[2]Required to be > Core Operating Limit Report RCS flow of 108.5 % Design Flow (DF)

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Enclosure 5.0

RADIAL PEAKING FACTORS AT IMPT

	8	9	10	11	12	13	14	15
H	1,1,Gp4 1.01 0.98 2.7%	2,2 1.28 1.24 3.4%	3,4,Gp3 1.25 1.25 0.1%	4,10 1.30 1.27 2.5%	5,14,Gp7 1.05 1.04 1.3%	6,21 1.15 1.14 0.6%	7,30,Gp6 0.96 0.98 -1.6%	8,37 0.45 0.45 -0.4%
K		9,3,Gp3 1.22 1.21 0.7%	10,6+8 1.33 1.31 2.2%	11,Inner,Gp1 1.35 1.34 0.6%	12,15+20 1.24 1.21 2.5%	13,22+29,Gp5 1.12 1.14 -1.1%	14,31+36 1.13 1.13 -0.1%	15,45 0.39 0.39 0.5%
L			16,12,Gp6 1.24 1.18 5.4%	17,17+18 1.33 1.29 3.1%	18,24+27,Gp8 1.22 1.24 -1.4%	19,Outer 1.18 1.18 0.0%	20,38+44,Gp4 1.07 1.08 -1.4%	21,46 0.29 0.30 -2.9%
M				22,26,Gp5 1.23 1.26 -2.0%	23,33+34 1.27 1.27 0.2%	24,40+42,Gp2 1.10 1.13 -2.0%	25,49 0.49 0.50 -2.6%	
N					26,41,Gp7 1.00 1.04 -4.0%	27,48 0.97 1.02 -4.9%	28,51 0.27 0.28 -2.7%	
O						29,52 0.36 0.39 -7.2%		

Predicted
Measured
% Dev

% Dev. = Predicted - Measured * 100 / Measured

Core Conditions

Power	50 %FP
Group 5	100% wd
Group 6	100%wd
Group 7	55% wd
Group 8	36% wd
Incore Imbalance	-7.83
RCS Boron	1662 ppmB
Max 1/8 Core % Deviation is +5.4% at L10	Acceptance criteria: <+15% of Predicted
Min 1/8 Core % Deviation is -7.2% at O13	Acceptance criteria: >-15% of Predicted
Maximum Peak Deviation is -0.6% at K11	Acceptance Criteria: <+5% of Predicted
Root Mean Square of Deviations is 2.4%	Acceptance Criteria: <7.5%

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Enclosure 5.1

TOTAL PEAKING FACTORS AT IMPT

	8	9	10	11	12	13	14	15
H	1,1,Gp4 1.20 1.16 3.6%	2,2 1.56 1.50 3.7%	3,4,Gp3 1.55 1.58 -1.8%	4,10 1.71 1.62 5.3%	5,14,Gp7 1.58 1.52 3.7%	6,21 1.54 1.54 0.3%	7,30,Gp6 1.26 1.25 1.0%	8,37 0.58 0.56 3.3%
K		9,3,Gp3 1.48 1.45 2.2%	10,6+8 1.66 1.64 1.4%	11,Inner,Gp1 1.74 1.73 0.7%	12,15+20 1.65 1.61 2.6%	13,22+29,Gp5 1.49 1.49 -0.2%	14,31+36 1.49 1.49 0.2%	15,45 0.51 0.50 1.3%
L			16,12,Gp6 1.56 1.48 5.2%	17,17+18 1.71 1.65 3.6%	18,24+27,Gp8 1.65 1.68 -1.5%	19,Outer 1.57 1.55 0.9%	20,38+44,Gp4 1.42 1.44 -1.4%	21,46 0.38 0.38 -0.4%
M				22,26,Gp5 1.64 1.68 -2.6%	23,33+34 1.75 1.74 0.9%	24,40+42,Gp2 1.51 1.55 -2.5%	25,49 0.65 0.65 -0.1%	
N					26,41,Gp7 1.57 1.61 -2.6%	27,48 1.41 1.33 6.3%	28,51 0.38 0.40 -5.5%	
O						29,52 0.52 0.55 -5.0%		

Predicted
Measured
% Dev

$$\% \text{ Dev.} = \frac{\text{Predicted - Measured} * 100}{\text{Measured}}$$

Core Conditions

Power	50 %FP
Group 5	100% wd
Group 6	100%wd
Group 7	55% wd
Group 8	36% wd
Incore Imbalance	-7.83
RCS Boron	1662 ppmB
Max 1/8 Core % Deviation is +6.3 % at N13	Acceptance criteria: <+20% of Predicted
Min 1/8 Core % Deviation is -5.5 % at N14	Acceptance criteria: >-20% of Predicted
Maximum Peak Deviation is -0.9 % at M12	Acceptance Criteria: <+7.5% of Predicted

RADIAL PEAKING FACTORS AT FPT

	8	9	10	11	12	13	14	15
H	1,1,Gp4 0.95 0.95 0.3%	2,2 1.20 1.19 1.2%	3,4,Gp3 1.20 1.22 -1.8%	4,10 1.29 1.27 1.9%	5,14,Gp7 1.18 1.15 2.6%	6,21 1.16 1.16 0.4%	7,30,Gp6 0.96 0.98 -1.5%	8,37 0.46 0.46 0.1%
K		9,3,Gp3 1.15 1.17 -1.0%	10,6+8 1.27 1.26 0.7%	11,Inner,Gp1 1.31 1.32 -0.2%	12,15+20 1.24 1.21 2.0%	13,22+29,Gp5 1.12 1.14 -1.4%	14,31+36 1.11 1.12 -0.3%	15,45 0.40 0.39 1.7%
L			16,12,Gp6 1.19 1.15 4.2%	17,17+18 1.28 1.25 2.3%	18,24+27,Gp8 1.20 1.23 -1.9%	19,Outer 1.16 1.16 0.4%	20,38+44,Gp4 1.05 1.06 -0.7%	21,46 0.30 0.30 -1.5%
M				22,26,Gp5 1.23 1.26 -2.6%	23,33+34 1.29 1.28 0.5%	24,40+42,Gp2 1.12 1.14 -1.4%	25,49 0.50 0.52 -3.0%	
N					26,41,Gp7 1.15 1.18 -2.7%	27,48 1.04 1.02 1.9%	28,51 0.30 0.30 -2.8%	
O						29,52 0.40 0.44 -7.9%		

Predicted
Measured
%Dev

$$\% \text{ Dev.} = \frac{\text{Predicted} - \text{Measured}}{\text{Measured}} * 100$$

Core Conditions

Power	100 %FP
Group 5	100% wd
Group 6	100%wd
Group 7	91% wd
Group 8	35% wd
Incore Imbalance	-5.30
RCS Boron	1444 ppmB
Max 1/8 Core % Deviation is +4.2% at L10	Acceptance criteria: <+15% of Predicted
Min 1/8 Core % Deviation is -7.9% at O13	Acceptance criteria: >-15% of Predicted
Maximum Peak Deviation is +0.2% at K11	Acceptance Criteria: <+5% of Predicted
Root Mean Square of Deviations is 1.9%	Acceptance Criteria: <7.5%

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TOTAL PEAKING FACTORS AT FPT

	8	9	10	11	12	13	14	15
H	1,1,Gp4 1.05 1.03 1.9%	2,2 1.33 1.31 1.5%	3,4,Gp3 1.33 1.38 -3.0%	4,10 1.46 1.44 0.9%	5,14,Gp7 1.35 1.31 2.7%	6,21 1.32 1.33 -0.4%	7,30,Gp6 1.10 1.12 -1.3%	8,37 0.52 0.51 1.8%
K		9,3,Gp3 1.28 1.27 0.6%	10,6+8 1.41 1.41 0.0%	11,Inner,Gp1 1.48 1.50 -1.2%	12,15+20 1.40 1.38 1.8%	13,22+29,Gp5 1.28 1.29 -0.8%	14,31+36 1.29 1.29 0.2%	15,45 0.45 0.45 0.9%
L			16,12,Gp6 1.33 1.28 3.6%	17,17+18 1.45 1.41 2.4%	18,24+27,Gp8 1.40 1.45 -3.7%	19,Outer 1.34 1.33 0.5%	20,38+44,Gp4 1.23 1.24 -1.1%	21,46 0.34 0.34 0.6%
M				22,26,Gp5 1.40 1.46 -4.2%	23,33+34 1.50 1.49 0.3%	24,40+42,Gp2 1.30 1.33 -2.4%	25,49 0.57 0.58 -1.8%	
N					26,41,Gp7 1.35 1.38 -2.2%	27,48 1.23 1.18 3.9%	28,51 0.34 0.35 -4.0%	
O						29,52 0.46 0.50 -7.4%		

Predicted
Measured
%Dev

$$\% \text{ Dev.} = \frac{\text{Predicted} - \text{Measured}}{\text{Measured}} * 100$$

Core Conditions

Power	100 %FP
Group 5	100% wd
Group 6	100%wd
Group 7	91% wd
Group 8	35% wd
Incore Imbalance	-5.30
RCS Boron	1444 ppmB
Max 1/8 Core % Deviation is +3.9% at N13	Acceptance criteria: <+20% of Predicted
Min 1/8 Core % Deviation is -7.4% at O13	Acceptance criteria: >-20% of Predicted
Maximum Peak Deviation is +0.3% at M12	Acceptance Criteria: <+7.5% of Predicted

CORE POWER DISTRIBUTION DATA SUMMARY AT

IMPT AND FPT PLATEAUS

Power Level (% FP)	50	100
Group 7/8 Positions (% wd)	55/36	91/35
RCS Boron Concentration (ppmB)	1662	1444
Incore Imbalance (% FP)	-7.83	-5.30

Oconee 2 Cycle 26
STARTUP TESTING REPORT
Enclosure 7.0

Core Symmetry Results at LPT

% Deviation= Highest-Lowest/AVG * 100%

Detector Number	Assembly Power	% Dev	Detector Number	Assembly Power	% Dev
6	3.94		24	3.54	
8	3.97		27	3.59	
AVG	3.96	0.76	AVG	3.57	1.40
5	4.01		23	3.36	
7	3.96		28	3.37	
9	3.93		32	3.25	
11	3.86		35	3.24	
13	3.91		39	3.38	
16	3.95		43	3.33	
19	3.89		47	3.35	
25	3.97		50	3.37	
AVG	3.94	3.81	AVG	3.33	4.20
			44	3.06	
			38	2.96	
			AVG	3.01	3.32
15	3.41		33	3.42	
20	3.36		34	3.51	
AVG	3.39	1.48	AVG	3.47	2.60
29	3.21		42	3.01	
22	3.17		40	3.05	
AVG	3.19	1.25	AVG	3.03	1.32
31	3.19				
36	3.12				
AVG	3.16	2.22			
17	3.76				
18	3.76				
AVG	3.76	0.00			

Evaluation of Group 6 Rod Worths Failing to Meet Review Criteria

The following analysis was performed by the General Office Nuclear Design personnel (OND) due to the failure to meet the review criteria of the Group 6 rod worth measurement:

During the O2C26 ZPPT, the group 6 rod worth measurement failed to meet the review criteria of ± 10%. The acceptance criteria was met. Since the accident analyses for O2C26 apply conservatism to predicted rod worths consistent with the test acceptance criteria of ±15%, the failure of the group 6 rod worth measurement to meet the review criteria does not represent a concern with regard to the safety analysis.

However, an examination of various items was conducted to ensure that the group 6 rod worth measurement's failure to meet the review criteria was not a result of another problem or issue.

OND reviewed the predictions for O2C26 and performed comparisons with recent cycles. There were no indications of problems with the computer models currently in use. There is nothing unusual in the fuel assemblies or assembly types which are present in the group 6 locations as compared to the group 7 locations (note that the group 7 measurements met both review and acceptance criteria). The O2C26 rod worth measurement deviations were consistent with what has been observed for recent Unit 2 cycles.

A review of the data which was collected during the rod worth measurements produced the following observations:

- The O1C27 and O3C26 flux data from the testing measurements were much tighter and closer to the top of the test band than O2C26. O2C26 group 6 measurements were taken particularly low in the test band.
- The O2C26 rod pushes in the lower end of Group 7 and 6 started too soon, closer to the bottom of the test band, especially for Group 6.
- The peak differential rod worth for O2C26 shifted downwards from the 40%wd – 30%wd range for pre-O2C26 to the 30%wd – 20%wd range for O2C26.

Thus, the deviation in predicted to measured group 6 rod worths for O2C26 appears to be a combination of noise in the measured data and typical overprediction of group 6 worth.