Florida Power & Light Company, 6501 South Ocean Drive, Jensen Beach, FL 34957

March 13, 2002

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10 CFR 50.36

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Re: St. Lucie Unit 2
Docket No. 50-389
Cycle 13 Startup Physics Testing Report

Pursuant to St. Lucie Unit 2 Technical Specification 6.9.1.1, the enclosed summary report of plant startup and power escalation testing for Cycle 13 is hereby submitted.

Please contact us should you have any questions.

Very truly yours,

Donald E. Jernigan
Vice President
St. Lucie Plant

DEJ/spt

Enclosure: St. Lucie Unit 2, Cycle 13 Startup Physics Testing Report

IE26

ST. LUCIE UNIT 2
CYCLE 13

STARTUP PHYSICS TESTING REPORT

(D/RE/930584-R0)

ST. LUCIE UNIT 2, CYCLE 13
REACTOR STARTUP PHYSICS
TESTING REPORT

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Startup Physics Testing Report

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I. Introduction

The purpose of this report is to provide a description of the fuel design and core load, and to summarize the startup testing performed at St. Lucie Unit 2 following the Cycle 13 refueling. The startup testing verifies that key core and plant parameters are as predicted. The major parts of this testing program include:

1) Initial criticality following refueling,
2) Zero power physics testing, and
3) Power ascension testing.

The test data satisfied all acceptance criteria and demonstrated general conformance to predicted performance.

II. <u>Cycle 13 Fuel Design</u>

The Cycle 13 reload consists entirely of fuel manufactured by Westinghouse Electric Company (WEC), previously ABB-Combustion Engineering. The Cycle 13 core consists of 68 fresh Region R fuel assemblies, 76 once burned Region P assemblies, 64 twice burned Region N assemblies, 8 twice burned Region K assemblies, and 1 thrice burned Region K assembly. The Region K assemblies are reinserted from the spent fuel pool. The fuel in the Cycle 13 core is arranged in a low leakage pattern similar to the design of the Cycle 12 core. Table 1 provides enrichment information for the Cycle 13 reload sub-batches.

The mechanical design of Region R fuel is essentially the same as that of Region P fuel, and consists of "value-added" fuel pellets and "guardian grid" design, first introduced in Cycle 11. Region R fuel includes some changes necessitated primarily by the transition of the fabrication of fuel rod assemblies from Hematite to the Columbia, S.C. manufacturing facility. The fuel rod design changes include elimination of alumina spacer disc located between the bottom of the fuel stack and the pedestal portion of the lower end cap, changes to the lengths of the end caps, and modifications to the plenum spring. These changes result in a slight increase in the net rod internal void volume, and lowering the active fuel stack by approximately 0.355 inches.

Region R assemblies consist of non-gadolinia enriched UO_2 fuel rods and UO_2-Gd_2O_3 gadolinia burnable absorber fuel rods. UO_2 fuel rods have a central zone enrichment of 4.1 and 4.45 w/o U-235, whereas the UO_2-Gd_2O_3 rods have a central zone of 4 and 8 w/o Gd_2O_3 dispersed in a 2.2 and 2.6 w/o U-235 carrier. The total Region R burnable absorber requirement for fresh fuel is 656 UO_2-Gd_2O_3 rods.

Cycle 13 reload (PC/M 00075) is based on the Reload Process Improvement (RPI) approach, first introduced in Cycle 12. This approach uses a checklist format to assess cycle-specific core designs for compliance with the existing safety analysis. Technical Specifications changes and the safety analyses supporting the implementation of RPI have been previously approved by the NRC in License Amendment #105.

The Cycle 13 core map is represented in Figure 1. The assembly serial numbers and control element assembly (CEA) serial numbers are given for each core location.

III. CEA Drop Time Testing

Following the core reload and prior to the approach to criticality, CEA drop time testing was performed. The objective of this test is to measure the time of insertion from the fully withdrawn position (upper electrical limit) to the 90% inserted position under hot, full flow conditions. The average CEA drop time was found to be 2.73 seconds with maximum and minimum times of 2.90 seconds and 2.21 seconds, respectively (Reference 7). All drop times were within the 3.1 second requirement of Technical Specification 3.1.3.4 and the reload PC/M 00075 requirements (Reference 6).

IV. Approach to Criticality

The approach to criticality involved diluting from a non-critical boron concentration of 1785 ppm to a predicted critical boron concentration of 1574 ppm. Inverse Count Rate Ratio (ICRR) plots were maintained during the dilution process using wide range channels B and D. Refer to Figures 2 and 3 for ICRR information. Table 2 summarizes the dilution rates and times, as well as beginning and ending boron concentrations.

Initial criticality for St. Lucie Unit 2, Cycle 13, was achieved on December 21, 2001 at 00:21 with CEA group 5 at 120 inches withdrawn and all other CEAs at the all-rods-out (ARO) position. The actual critical concentration was measured to be 1573 ppm (Reference 1).

V. Zero Power Physics Testing

To ensure that the operating characteristics of the Cycle 13 core were consistent with the design predictions, the following tests were performed:

1) Reactivity Computer Checkout;
2) All Rods Out Critical Boron Concentration;
3) Isothermal Temperature Coefficient Measurement; and
4) CEA Group Rod Worth Measurements.

Proper operation of the reactivity computer is ensured by performing the "Reactivity Computer Checkout." This part of the testing determines the appropriate testing range and checks that reactivity changes are being correctly calculated by the reactivity computer's internal algorithms. The testing range is selected such that the signal to noise ratio is maximized and that testing is performed below the point of adding nuclear heat. The reactivity calculation is checked by performing a positive and negative reactor period test through respective introduction of a known amount of positive and negative reactivity. The results of the reactivity computer checkout were compared to the appropriate predictions supplied in the reload PC/M 00075 (Reference 6). Satisfactory agreement was obtained.

The measurement of the all-rods-out (ARO) critical boron concentration was performed. The measured value was 1577 ppm which compared favorably with the design value of 1577 ppm (Reference 2). This was within the acceptance limits of ± 100 PPM.

The measurement of the isothermal temperature coefficient was performed and the resulting moderator temperature coefficient (MTC) was derived. The MTC was determined to be +0.709 pcm/°F which fell well within the acceptance criteria of ± 2.0 pcm/°F of the design MTC of +0.102 pcm/°F (corrected). This satisfies Unit 2 Technical Specification 3.1.1.4a which states that the MTC shall be less positive than 5.0 pcm/°F when reactor power is less than or equal to 70% rated thermal power.

Rod worth measurements were performed using the rod swap methodology. This method involves exchanging a reference group, which is measured by the boration dilution technique, with each of the remaining test groups. A comparison of the measured and design CEA reactivity worths is provided in Table 3. The following acceptance criteria apply to the measurements made:

1) The measured value of each test group, or supergroup measured, is within ±15% or ±100 pcm of its corresponding design CEA worths, whichever is greater and,

2) The measured worth of the reference group and the total worth for all the CEA groups measured is within ± 10% of the total design worth.

All acceptance criteria were met.

VI. Power Ascension Program

During power ascension, the fixed incore detector system is utilized to verify that the core is loaded properly and there are no abnormalities occurring in various core parameters (core peaking factors, linear heat rate, and tilt) for power plateaus at 30%, 45%, and greater than 98% rated thermal power. A shape annealing factor (Reference 5) test was performed in conjunction with the power ascension (Reference 3). This test was required due to the replacement of the "A" Linear Range nuclear instrument channel detector.

A summary of the flux maps at the 30%, 45% and 98% power levels is provided in Figures 4, 5 and 6. These flux maps are used for comparing the measured power distribution with the predicted power distribution. For the purposes of power ascension, the acceptance criteria require the root mean square (RMS) value of the power deviation to be less than or equal to 5%. The individual assembly powers should be within 10% of the predicted power for assembly powers greater than or equal to 0.9 (30% and 98% plateaus). In addition, for the 30% plateau the relative power density (RPD) should be within 0.1 RPD units of predicted for assembly powers less than or equal to 0.9. These criteria were satisfied.

Additionally, calorimetric, nuclear, and delta T power calibrations were performed at each power plateau prior to advancing reactor power to the next higher level specified by procedure.

VII. Summary

Compliance with the applicable Unit 2 Technical Specifications was satisfactory and all acceptance criteria were met.

VIII. References

1) *"Initial Criticality,"* Pre-Operational Procedure 2-3200088, Rev. 22.

2) *"Reload Startup Physics Testing,"* Pre-Operational Procedure 3200091, Rev. 22

3) *"Reactor Engineering Power Ascension Program,"* Pre-Operational Procedure 3200092, Rev. 28.

4) St. Lucie Unit 2 Technical Specifications, Amendment 123.

5) *"Shape Annealing Factor Test,"* Pre-Operational Test Procedure 3200093, Rev. 10A.

6) St. Lucie Unit 2 Cycle 13 Reload PC/M #00075, Rev 1.

7) *"Periodic Rod Drop Time and CEA Position Functional Test,"* Operating Procedure 2-0110054, Rev. 19B.

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FIGURE 1
CYCLE 13 CORE LOADING PATTERN

N ↑

Row	Y	X	W	V	T	S	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
21								N06		N48		N42		N05							
20					N47	N54	P61		R39 24		R58		R42 56		P49	N56	N10				
19				N41	R44 126	P37	R60 64		N17		P73 210		N19		R61 9	P45	R50 66	N39			
18			N50	R53 205	P32	R03 53	P19		R11 48		P05		R14 28		P16	R24 73	P18	R54 200	N51		
17		N09	R51 62	P09	R25 61	K51	P53 122		N18		P70 29		N15		P55 117	K54	R02 38	P31	R38 123	N33	
16		N62	P34	R33 30	K55	R06 37	P48		R19 104		N32		R20 100		P36	R16 36	K50	R17 114	P47	N63	
15		P60	R66 116	P21	P50 115	P38	P02 203		P12		P67 105		P28		P01 204	P40	P63 112	P11	R67 43	P59	
14	N08																				N03
13		R52 35	N14	R10 67	N23	R13 102	P23		R01 50		N57		R23		P14	R09 13	N24	R08 54	N27	R40 68	
12	N43																				N44
11		R57	P72 202	P06	P74 63	N30	P68 55		N53		K76 119		N64		P65 103	N31	P75 60	P07	P76 209	R68	
10	N45																				N46
9		R47 57	N22	R30 106	N28	R28 118	P24		R22		N61		R36 65		P25	R21 25	N16	R18 120	N21	R48 59	
8	N02																				N04
7		P52	R59 6	P26	P58 101	P39	P04 207		P17		P66 108		P15		P03 208	P33	P57 109	P20	R64 75	P64	
6		N55	P42	R27 5	K49	R07 58	P43		R32 26		N29		R05 110		P44	R12 46	K56	R26 72	P41	N60	
5		N34	R45 127	P30	R15 45	K53	P56 111		N25		P71 52		N13		P62 121	K52	R29 107	P10	R46 128	N12	
4			N40	R55 206	P13	R31 41	P27		R35 27		P08		R04 42		P22	R34 19	P29	R56 211	N35		
3				N36	R41 124	P35	R65 51		N20		P69 201		N26		R62 113	P46	R43 125	N52			
2					N11	N58	P54		R37 39		R63		R49 49		P51	N59	N49				
1								N01		N37		N38		N07							

Assembly Serial # → XXX
Insert Serial # → ##

Figure 2. Wide Range Channel B Boron Dilution

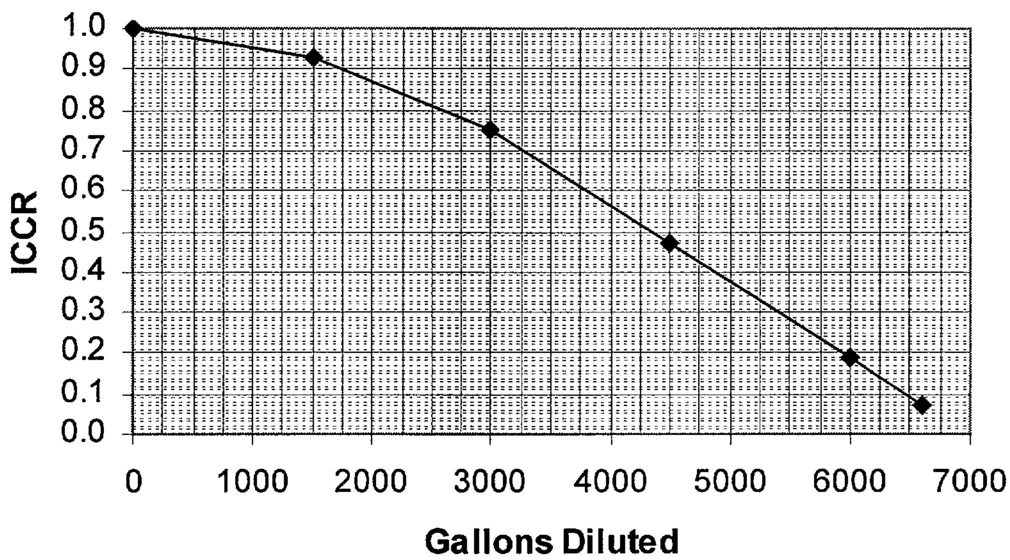

Figure 3. Wide Range Channel D Boron Dilution

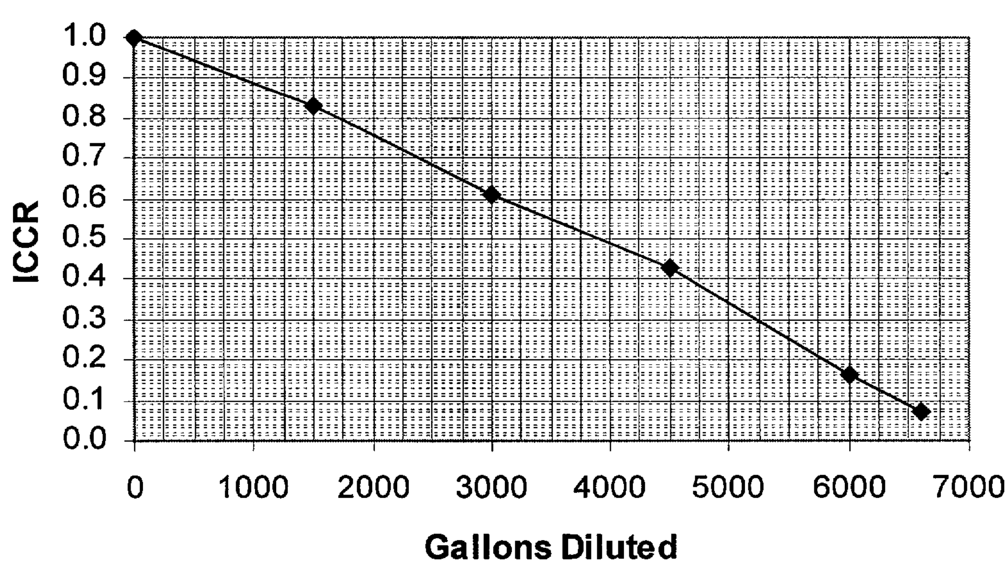

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Figure 4
Power Distribution Comparison With Design - 30% Power

Unit 2

	Measured: BEACON	Design:
Source	u2 30% plateau.out	PCM 00075 Rev. 1
Power Level	29.4%	30%
Exposure	1.8 EFPH	5 EFPH
CEA Position	5 @ 122" w/d	5@122" w/d
Boron Conc.	1487	1426

N ↑

Column labels: R P N M L K J H G F E D C B A (right side) / T S V W X Y (left side); row labels 21 to 1 (top to bottom).

Box #	Measured	Design	Delta	% Diff.
217	0.280	0.300	-0.020	-7.1
216	0.390	0.41	-0.020	-5.1
215	0.380	0.41	-0.030	-7.9
214	0.280	0.3	-0.020	-7.1
213	0.280	0.290	-0.010	-3.6
212	0.420	0.440	-0.020	-4.8
211	0.810	0.830	-0.020	-2.5
210	1.240	1.270	-0.030	-2.4
209	1.220	1.250	-0.030	-2.5
208	1.240	1.270	-0.030	-2.4
207	0.810	0.830	-0.020	-2.5
206	0.420	0.440	-0.020	-4.8
205	0.270	0.280	-0.010	-3.7
204	0.410	0.430	-0.020	-4.9
203	1.060	1.100	-0.040	-3.8
202	1.040	1.060	-0.020	-1.9
201	1.330	1.340	-0.010	-0.8
200	1.050	1.050	0.000	0.0
199	1.200	1.200	0.000	0.0
198	1.040	1.050	-0.010	-1.0
197	1.330	1.340	-0.010	-0.8
196	1.050	1.060	-0.010	-1.0
195	1.070	1.090	-0.020	-1.9
194	0.420	0.430	-0.010	-2.4
193	0.410	0.430	-0.020	-4.9
192	1.160	1.190	-0.030	-2.6
191	1.130	1.140	-0.010	-0.9
190	1.320	1.320	0.000	0.0
189	1.210	1.200	0.010	0.8
188	1.370	1.350	0.020	1.5
187	1.190	1.170	0.020	1.7
186	1.370	1.350	0.020	1.5
185	1.210	1.200	0.010	0.8
184	1.330	1.320	0.010	0.8
183	1.140	1.130	0.010	0.9
182	1.190	1.190	0.000	0.0
181	0.420	0.430	-0.010	-2.4
180	0.260	0.280	-0.020	-7.7
179	1.050	1.090	-0.040	-3.8
178	1.110	1.130	-0.020	-1.8
177	1.260	1.260	0.000	0.0
176	0.810	0.800	0.010	1.2
175	1.260	1.240	0.020	1.6
174	1.020	0.990	0.030	2.9
173	1.170	1.140	0.030	2.6
172	1.020	1.000	0.020	2.0
171	1.270	1.240	0.030	2.4
170	0.820	0.800	0.020	2.4
169	1.280	1.260	0.020	1.6
168	1.150	1.140	0.010	0.9
167	1.090	1.100	-0.010	-0.9
166	0.280	0.290	-0.010	-3.6
165	0.420	0.440	-0.020	-4.8
164	1.030	1.060	-0.030	-2.9
163	1.310	1.320	-0.010	-0.8
162	0.810	0.800	0.010	1.2
161	1.300	1.280	0.020	1.5
160	1.240	1.210	0.030	2.4
159	1.330	1.300	0.030	2.3
158	0.970	0.950	0.020	2.1
157	1.330	1.300	0.030	2.3
156	1.250	1.210	0.040	3.2
155	1.320	1.280	0.040	3.0
154	0.820	0.800	0.020	2.4
153	1.350	1.320	0.030	2.2
152	1.060	1.060	0.000	0.0
151	0.430	0.440	-0.010	-2.3
150	0.800	0.830	-0.030	-3.7
149	1.310	1.340	-0.030	-2.3
148	1.190	1.200	-0.010	-0.8
147	1.250	1.240	0.010	0.8
146	1.240	1.210	0.030	2.4
145	1.170	1.150	0.020	1.7
144	1.150	1.130	0.020	1.7
143	1.180	1.150	0.030	2.5
142	1.160	1.130	0.030	2.6
141	1.180	1.150	0.030	2.5
140	1.260	1.210	0.050	4.0
139	1.280	1.240	0.040	3.1
138	1.220	1.200	0.020	1.6
137	1.350	1.340	0.010	0.7
136	0.810	0.830	-0.020	-2.5
135	0.280	0.300	-0.020	-7.1
133	1.220	1.270	-0.050	-4.1
132	1.030	1.050	-0.020	-1.9
131	1.340	1.350	-0.010	-0.7
130	1.000	1.000	0.000	0.0
129	1.310	1.300	0.010	0.8
128	1.140	1.130	0.010	0.9
127	1.180	1.170	0.010	0.8
126	0.810	0.810	0.000	0.0
125	1.190	1.170	0.020	1.7
124	1.160	1.130	0.030	2.6
123	1.340	1.300	0.040	3.0
122	1.020	0.990	0.030	2.9
121	1.380	1.350	0.030	2.2
120	1.050	1.050	0.000	0.0
119	1.240	1.270	-0.030	-2.4
134	0.280	0.300	-0.020	-7.1
118	0.380	0.410	-0.030	-7.9
116	1.200	1.250	-0.050	-4.2
115	1.180	1.200	-0.020	-1.7
114	1.170	1.170	0.000	0.0
113	1.150	1.140	0.010	0.9
112	0.960	0.950	0.010	1.0
111	1.160	1.150	0.010	0.9
110	0.810	0.810	0.000	0.0
109	0.63	0.630	0.000	0.0
108	0.820	0.810	0.010	1.2
107	1.180	1.150	0.030	2.5
106	0.980	0.950	0.030	3.1
105	1.170	1.140	0.030	2.6
104	1.190	1.170	0.020	1.7
103	1.200	1.200	0.000	0.0
102	1.220	1.250	-0.030	-2.5
117	0.380	0.410	-0.030	-7.9
101	0.380	0.410	-0.030	-7.9
99	1.230	1.270	-0.040	-3.3
98	1.030	1.050	-0.020	-1.9
97	1.350	1.350	0.000	0.0
96	1.000	0.990	0.010	1.0
95	1.310	1.300	0.010	0.8
94	1.140	1.130	0.010	0.9
93	1.170	1.170	0.000	0.0
92	0.810	0.810	0.000	0.0
91	1.180	1.170	0.010	0.8
90	1.150	1.130	0.020	1.7
89	1.330	1.300	0.030	2.3
88	1.020	1.000	0.020	2.0
87	1.370	1.350	0.020	1.5
86	1.050	1.050	0.000	0.0
85	1.240	1.270	-0.030	-2.4
100	0.380	0.410	-0.030	-7.9
84	0.280	0.300	-0.020	-7.1
82	0.810	0.830	-0.020	-2.5
81	1.330	1.340	-0.010	-0.8
80	1.200	1.200	0.000	0.0
79	1.250	1.240	0.010	0.8
78	1.240	1.210	0.030	2.4
77	1.160	1.150	0.010	0.9
76	1.140	1.130	0.010	0.9
75	1.160	1.150	0.010	0.9
74	1.140	1.130	0.010	0.9
73	1.170	1.150	0.020	1.7
72	1.240	1.210	0.030	2.4
71	1.260	1.240	0.020	1.6
70	1.210	1.200	0.010	0.8
69	1.330	1.340	-0.010	-0.8
68	0.810	0.830	-0.020	-2.5
83	0.280	0.300	-0.020	-7.1
67	0.430	0.440	-0.010	-2.3
66	1.050	1.060	-0.010	-1.0
65	1.330	1.320	0.010	0.8
64	0.810	0.800	0.010	1.2
63	1.310	1.280	0.030	2.3
62	1.240	1.210	0.030	2.4
61	1.320	1.300	0.020	1.5
60	0.960	0.950	0.010	1.0
59	1.310	1.300	0.010	0.8
58	1.240	1.210	0.030	2.4
57	1.300	1.280	0.020	1.5
56	0.810	0.800	0.010	1.2
55	1.330	1.320	0.010	0.8
54	1.050	1.060	-0.010	-1.0
53	0.420	0.440	-0.020	-4.8
52	0.280	0.290	-0.010	-3.6
51	1.080	1.100	-0.020	-1.9
50	1.140	1.140	0.000	0.0
49	1.270	1.260	0.010	0.8
48	0.810	0.800	0.010	1.2
47	1.260	1.240	0.020	1.6
46	1.010	1.000	0.010	1.0
45	1.160	1.140	0.020	1.7
44	1.010	0.990	0.020	2.0
43	1.250	1.240	0.010	0.8
42	0.810	0.800	0.010	1.2
41	1.260	1.260	0.000	0.0
40	1.130	1.130	0.000	0.0
39	1.070	1.090	-0.020	-1.9
38	0.270	0.280	-0.010	-3.7
37	0.420	0.430	-0.010	-2.4
36	1.180	1.190	-0.010	-0.8
35	1.130	1.130	0.000	0.0
34	1.330	1.320	0.010	0.8
33	1.210	1.200	0.010	0.8
32	1.370	1.350	0.020	1.5
31	1.180	1.170	0.010	0.8
30	1.360	1.350	0.010	0.7
29	1.200	1.200	0.000	0.0
28	1.320	1.320	0.000	0.0
27	1.130	1.140	-0.010	-0.9
26	1.170	1.190	-0.020	-1.7
25	0.410	0.430	-0.020	-4.9
24	0.410	0.430	-0.020	-4.9
23	1.070	1.090	-0.020	-1.9
22	1.050	1.060	-0.010	-1.0
21	1.340	1.340	0.000	0.0
20	1.050	1.050	0.000	0.0
19	1.200	1.200	0.000	0.0
18	1.040	1.050	-0.010	-1.0
17	1.330	1.340	-0.010	-0.8
16	1.040	1.060	-0.020	-1.9
15	1.070	1.100	-0.030	-2.8
14	0.410	0.430	-0.020	-4.9
13	0.270	0.280	-0.010	-3.7
12	0.430	0.440	-0.010	-2.3
11	0.810	0.830	-0.020	-2.5
10	1.250	1.270	-0.020	-1.6
9	1.230	1.250	-0.020	-1.6
8	1.240	1.270	-0.030	-2.4
7	0.810	0.830	-0.020	-2.5
6	0.420	0.440	-0.020	-4.8
5	0.280	0.290	-0.010	-3.6
4	0.290	0.300	-0.010	-3.4
3	0.390	0.410	-0.020	5.1
2	0.390	0.410	-0.020	-5.1
1	0.280	0.300	-0.020	-7.1

RMS Deviation: 2.02%

Key:

Box #
Measured
Design
Delta
% Diff.

St. Lucie Unit 2, Cycle 13
Startup Physics Testing Report

Figure 5
Power Distribution Comparison With Design - 45% Power

Unit 2

	Measured: BEACON	Design:
Source	u2 45% plateau.out	PCM 00075 Rev. 1
Power Level	45.5%	45%
Exposure	4.2	10 EFPH
CEA Position	5@122" w/d	5@122" w/d
Boron Conc.	1404	1365

N ↑

Box #	Measured	Design	Delta	% Diff.
217	0.290	0.300	-0.010	-3.4
216	0.390	0.41	-0.020	-5.1
215	0.390	0.41	-0.020	-5.1
214	0.280	0.3	-0.020	-7.1
213	0.280	0.290	-0.010	-3.6
212	0.430	0.440	-0.010	-2.3
211	0.810	0.830	-0.020	-2.5
210	1.240	1.260	-0.020	-1.6
209	1.210	1.240	-0.030	-2.5
208	1.230	1.260	-0.030	-2.4
207	0.810	0.830	-0.020	-2.5
206	0.430	0.440	-0.010	-2.3
205	0.270	0.280	-0.010	-3.7
204	0.420	0.430	-0.010	-2.4
203	1.070	1.090	-0.020	-1.9
202	1.040	1.060	-0.020	-1.9
201	1.330	1.330	0.000	0.0
200	1.050	1.050	0.000	0.0
199	1.200	1.200	0.000	0.0
198	1.040	1.050	-0.010	-1.0
197	1.320	1.330	-0.010	-0.8
196	1.040	1.050	-0.010	-1.0
195	1.070	1.080	-0.010	-0.9
194	0.420	0.430	-0.010	-2.4
193	0.410	0.430	-0.020	-4.9
192	1.160	1.190	-0.030	-2.6
191	1.130	1.140	-0.010	-0.9
190	1.330	1.320	0.010	0.8
189	1.210	1.190	0.020	1.7
188	1.370	1.350	0.020	1.5
187	1.190	1.170	0.020	1.7
186	1.370	1.350	0.020	1.5
185	1.210	1.200	0.010	0.8
184	1.330	1.320	0.010	0.8
183	1.140	1.130	0.010	0.9
182	1.190	1.190	0.000	0.0
181	0.430	0.430	0.000	0.0
180	0.270	0.280	-0.010	-3.7
179	1.060	1.080	-0.020	-1.9
178	1.120	1.130	-0.010	-0.9
177	1.260	1.260	0.000	0.0
176	0.820	0.810	0.010	1.2
175	1.260	1.240	0.020	1.6
174	1.020	1.000	0.020	2.0
173	1.170	1.150	0.020	1.7
172	1.020	1.000	0.020	2.0
171	1.270	1.240	0.030	2.4
170	0.820	0.810	0.010	1.2
169	1.280	1.260	0.020	1.6
168	1.150	1.140	0.010	0.9
167	1.090	1.090	0.000	0.0
166	0.290	0.290	0.000	0.0
165	0.420	0.440	-0.020	-4.8
164	1.030	1.050	-0.020	-1.9
163	1.310	1.320	-0.010	-0.8
162	0.810	0.810	0.000	0.0
161	1.310	1.280	0.030	2.3
160	1.250	1.220	0.030	2.4
159	1.330	1.300	0.030	2.3
158	0.980	0.960	0.020	2.0
157	1.340	1.300	0.040	3.0
156	1.250	1.220	0.030	2.4
155	1.320	1.280	0.040	3.0
154	0.830	0.810	0.020	2.4
153	1.350	1.320	0.030	2.2
152	1.060	1.060	0.000	0.0
151	0.440	0.440	0.000	0.0
150	0.800	0.830	-0.030	-3.7
149	1.310	1.330	-0.020	-1.5
148	1.190	1.200	-0.010	-0.8
147	1.250	1.240	0.010	0.8
146	1.240	1.220	0.020	1.6
145	1.180	1.150	0.030	2.5
144	1.160	1.140	0.020	1.7
143	1.180	1.160	0.020	1.7
142	1.160	1.140	0.020	1.7
141	1.190	1.150	0.040	3.4
140	1.260	1.220	0.040	3.2
139	1.270	1.240	0.030	2.4
138	1.220	1.190	0.030	2.5
137	1.340	1.330	0.010	0.7
136	0.820	0.830	-0.010	-1.2
135	0.280	0.300	-0.020	-7.1
134	0.290	0.300	-0.010	-3.4
133	1.210	1.260	-0.050	-4.1
132	1.020	1.050	-0.030	-2.9
131	1.340	1.350	-0.010	-0.7
130	1.000	1.000	0.000	0.0
129	1.320	1.300	0.020	1.5
128	1.150	1.140	0.010	0.9
127	1.190	1.180	0.010	0.8
126	0.830	0.820	0.010	1.2
125	1.200	1.180	0.020	1.7
124	1.170	1.140	0.030	2.6
123	1.340	1.300	0.040	3.0
122	1.020	1.000	0.020	2.0
121	1.380	1.350	0.030	2.2
120	1.050	1.050	0.000	0.0
119	1.240	1.260	-0.020	-1.6
118	0.380	0.410	-0.030	-7.9
117	0.390	0.410	-0.020	-5.1
116	1.190	1.240	-0.050	-4.2
115	1.170	1.200	-0.030	-2.6
114	1.160	1.170	-0.010	-0.9
113	1.150	1.150	0.000	0.0
112	0.960	0.960	0.000	0.0
111	1.170	1.160	0.010	0.9
110	0.820	0.820	0.000	1.2
109	0.65	0.640	0.010	1.5
108	0.830	0.820	0.010	1.2
107	1.190	1.160	0.030	2.5
106	0.980	0.960	0.020	2.0
105	1.170	1.150	0.020	1.7
104	1.190	1.170	0.020	1.7
103	1.200	1.200	0.000	0.0
102	1.210	1.240	-0.030	-2.5
101	0.380	0.410	-0.030	-7.9
100	0.390	0.410	-0.020	-5.1
99	1.220	1.260	-0.040	-3.3
98	1.030	1.050	-0.020	-1.9
97	1.350	1.350	0.000	0.0
96	1.000	1.000	0.000	0.0
95	1.310	1.300	0.010	0.8
94	1.150	1.140	0.010	0.9
93	1.180	1.180	0.000	0.0
92	0.820	0.820	0.000	0.0
91	1.190	1.180	0.010	0.8
90	1.160	1.140	0.020	1.7
89	1.330	1.300	0.030	2.3
88	1.020	1.000	0.020	2.0
87	1.370	1.350	0.020	1.5
86	1.040	1.050	-0.010	-1.0
85	1.240	1.260	-0.020	-1.6
84	0.280	0.300	-0.020	-7.1
83	0.290	0.300	-0.010	-3.4
82	0.810	0.830	-0.020	-2.5
81	1.320	1.330	-0.010	-0.8
80	1.190	1.190	0.000	0.0
79	1.250	1.240	0.010	0.8
78	1.230	1.220	0.010	0.8
77	1.160	1.150	0.010	0.9
76	1.140	1.140	0.000	0.0
75	1.170	1.160	0.010	0.9
74	1.150	1.140	0.010	0.9
73	1.170	1.150	0.020	1.7
72	1.240	1.220	0.020	1.6
71	1.260	1.240	0.020	1.6
70	1.210	1.200	0.010	0.8
69	1.330	1.330	0.000	0.0
68	0.810	0.830	-0.020	-2.5
67	0.430	0.440	-0.010	-2.3
66	1.040	1.060	-0.020	-1.9
65	1.320	1.320	0.000	0.0
64	0.810	0.810	0.000	0.0
63	1.300	1.280	0.020	1.5
62	1.230	1.220	0.010	0.8
61	1.310	1.300	0.010	0.8
60	0.960	0.960	0.000	0.0
59	1.310	1.300	0.010	0.8
58	1.230	1.220	0.010	0.8
57	1.300	1.280	0.020	1.5
56	0.820	0.810	0.010	1.2
55	1.320	1.320	0.000	0.0
54	1.040	1.050	-0.010	-1.0
53	0.430	0.440	-0.010	-2.3
52	0.280	0.290	-0.010	-3.6
51	1.070	1.090	-0.020	-1.9
50	1.130	1.140	-0.010	-0.9
49	1.260	1.260	0.000	0.0
48	0.810	0.810	0.000	0.0
47	1.250	1.240	0.010	0.8
46	1.010	1.000	0.010	1.0
45	1.150	1.150	0.000	0.0
44	1.000	1.000	0.000	0.0
43	1.250	1.240	0.010	0.8
42	0.810	0.810	0.000	0.0
41	1.260	1.260	0.000	0.0
40	1.120	1.130	-0.010	-0.9
39	1.070	1.080	-0.010	-0.9
38	0.270	0.280	-0.010	-3.7
37	0.420	0.430	-0.010	-2.4
36	1.170	1.190	-0.020	-1.7
35	1.120	1.130	-0.010	-0.9
34	1.320	1.320	0.000	0.0
33	1.200	1.200	0.000	0.0
32	1.350	1.350	0.000	0.0
31	1.170	1.170	0.000	0.0
30	1.350	1.350	0.000	0.0
29	1.190	1.190	0.000	0.0
28	1.310	1.320	-0.010	-0.8
27	1.130	1.140	-0.010	-0.9
26	1.170	1.190	-0.020	-1.7
25	0.420	0.430	-0.010	-2.4
24	0.420	0.430	-0.010	-2.4
23	1.060	1.080	-0.020	-1.9
22	1.040	1.050	-0.010	-1.0
21	1.320	1.330	-0.010	-0.8
20	1.040	1.050	-0.010	-1.0
19	1.190	1.200	-0.010	-0.8
18	1.040	1.050	-0.010	-1.0
17	1.310	1.330	-0.020	-1.5
16	1.040	1.060	-0.020	-1.9
15	1.060	1.090	-0.030	-2.8
14	0.420	0.430	-0.010	-2.4
13	0.270	0.280	-0.010	-3.7
12	0.430	0.440	-0.010	-2.3
11	0.810	0.830	-0.020	-2.5
10	1.230	1.260	-0.030	-2.4
9	1.210	1.240	-0.030	-2.5
8	1.230	1.260	-0.030	-2.4
7	0.810	0.830	-0.020	-2.5
6	0.430	0.440	-0.010	-2.3
5	0.280	0.290	-0.010	-3.6
4	0.290	0.300	-0.010	-3.4
3	0.390	0.410	-0.020	-5.1
2	0.390	0.410	-0.020	-5.1
1	0.290	0.300	-0.010	-3.4

RMS Deviation: 1.81%

Key:

Box #
Measured
Design
Delta
% Diff.

St. Lucie Unit 2, Cycle 13
Startup Physics Testing Report

Figure 6
Power Distribution Comparison With Design - 98%

Unit 2

	Measured: BEACON	Design:
Source	u2 98% plateau.out	PCM 00075 Rev. 1
Power Level	96%	100%
Exposure	71.4	60 EFPH
CEA Position	5@128" w/d	5@137" w/d
Boron Conc.	1170	1133

N (arrow pointing up)

Key: Box # / Measured / Design / Delta / % Diff.

Row	Box #	Measured	Design	Delta	% Diff.
21	217	0.290	0.300	-0.010	-3.4
21	216	0.390	0.41	-0.020	-5.1
21	215	0.390	0.41	-0.020	-5.1
21	214	0.290	0.3	-0.010	-3.4
20	213	0.290	0.300	-0.010	-3.4
20	212	0.430	0.450	-0.020	-4.7
20	211	0.800	0.820	-0.020	-2.5
20	210	1.200	1.220	-0.020	-1.7
20	209	1.170	1.190	-0.020	-1.7
20	208	1.190	1.220	-0.030	-2.5
20	207	0.800	0.820	-0.020	-2.5
20	206	0.430	0.450	-0.020	-4.7
20	205	0.280	0.290	-0.010	-3.6
19	204	0.420	0.440	-0.020	-4.8
19	203	1.050	1.080	-0.030	-2.9
19	202	1.030	1.040	-0.010	-1.0
19	201	1.300	1.300	0.000	0.0
19	200	1.030	1.030	0.000	0.0
19	199	1.180	1.190	-0.010	-0.8
19	198	1.030	1.030	0.000	0.0
19	197	1.290	1.300	-0.010	-0.8
19	196	1.030	1.040	-0.010	-1.0
19	195	1.060	1.070	-0.010	-0.9
19	194	0.430	0.440	-0.010	-2.3
18	193	0.420	0.440	-0.020	-4.8
18	192	1.150	1.180	-0.030	-2.6
18	191	1.120	1.130	-0.010	-0.9
18	190	1.310	1.300	0.010	0.8
18	189	1.200	1.180	0.020	1.7
18	188	1.360	1.330	0.030	2.2
18	187	1.190	1.170	0.020	1.7
18	186	1.350	1.330	0.020	1.5
18	185	1.200	1.180	0.020	1.7
18	184	1.320	1.300	0.020	1.5
18	183	1.130	1.120	0.010	0.9
18	182	1.170	1.180	-0.010	-0.9
18	181	0.430	0.440	-0.010	-2.3
17	180	0.280	0.290	-0.010	-3.6
17	179	1.040	1.070	-0.030	-2.9
17	178	1.110	1.120	-0.010	-0.9
17	177	1.260	1.250	0.010	0.8
17	176	0.840	0.830	0.010	1.2
17	175	1.280	1.240	0.040	3.1
17	174	1.040	1.010	0.030	2.9
17	173	1.190	1.160	0.030	2.5
17	172	1.040	1.010	0.030	2.9
17	171	1.290	1.250	0.040	3.1
17	170	0.850	0.830	0.020	2.4
17	169	1.280	1.250	0.030	2.3
17	168	1.140	1.130	0.010	0.9
17	167	1.080	1.080	0.000	0.0
17	166	0.300	0.300	0.000	0.0
16	165	0.430	0.450	-0.020	-4.7
16	164	1.020	1.040	-0.020	-2.0
16	163	1.290	1.300	-0.010	-0.8
16	162	0.840	0.830	0.010	1.2
16	161	1.320	1.300	0.020	1.5
16	160	1.270	1.230	0.040	3.1
16	159	1.350	1.310	0.040	3.0
16	158	1.010	0.980	0.030	3.0
16	157	1.360	1.320	0.040	2.9
16	156	1.280	1.230	0.050	3.9
16	155	1.340	1.300	0.040	3.0
16	154	0.850	0.830	0.020	2.4
16	153	1.330	1.300	0.030	2.3
16	152	1.050	1.040	0.010	1.0
16	151	0.440	0.450	-0.010	-2.3
15	150	0.790	0.820	-0.030	-3.8
15	149	1.270	1.300	-0.030	-2.4
15	148	1.180	1.180	0.000	0.0
15	147	1.260	1.250	0.010	0.8
15	146	1.260	1.230	0.030	2.4
15	145	1.210	1.190	0.020	1.7
15	144	1.190	1.170	0.020	1.7
15	143	1.220	1.190	0.030	2.5
15	142	1.200	1.160	0.040	3.3
15	141	1.230	1.190	0.040	3.3
15	140	1.280	1.230	0.050	3.9
15	139	1.290	1.240	0.050	3.9
15	138	1.210	1.180	0.030	2.5
15	137	1.310	1.300	0.010	0.8
15	136	0.810	0.820	-0.010	-1.2
14	135	0.280	0.300	-0.020	-7.1
14	134	0.290	0.300	-0.010	-3.4
13	133	1.170	1.220	-0.050	-4.3
13	132	1.010	1.030	-0.020	-2.0
13	131	1.330	1.330	0.000	0.0
13	130	1.020	1.010	0.010	1.0
13	129	1.340	1.320	0.020	1.5
13	128	1.180	1.160	0.020	1.7
13	127	1.230	1.210	0.020	1.6
13	126	0.870	0.860	0.010	1.1
13	125	1.240	1.210	0.030	2.4
13	124	1.200	1.170	0.030	2.5
13	123	1.360	1.310	0.050	3.7
13	122	1.040	1.010	0.030	2.9
13	121	1.360	1.330	0.030	2.2
13	120	1.040	1.030	0.010	1.0
13	119	1.200	1.220	-0.020	-1.7
12	118	0.380	0.410	-0.030	-7.9
12	117	0.390	0.410	-0.020	-5.1
11	116	1.150	1.190	-0.040	-3.5
11	115	1.160	1.190	-0.030	-2.6
11	114	1.160	1.170	-0.010	-0.9
11	113	1.170	1.160	0.010	0.9
11	112	0.990	0.980	0.010	1.0
11	111	1.200	1.190	0.010	0.8
11	110	0.860	0.860	0.000	0.0
11	109	0.69	0.690	0.000	0.0
11	108	0.870	0.860	0.010	1.1
11	107	1.220	1.190	0.030	2.5
11	106	1.010	0.980	0.030	3.0
11	105	1.190	1.160	0.030	2.5
11	104	1.190	1.170	0.020	1.7
11	103	1.190	1.190	0.000	0.0
11	102	1.170	1.190	-0.020	-1.7
10	101	0.380	0.410	-0.030	-7.9
10	100	0.390	0.410	-0.020	-5.1
9	99	1.180	1.220	-0.040	-3.4
9	98	1.020	1.030	-0.010	-1.0
9	97	1.330	1.330	0.000	0.0
9	96	1.020	1.010	0.010	1.0
9	95	1.330	1.310	0.020	1.5
9	94	1.180	1.170	0.010	0.8
9	93	1.210	1.210	0.000	0.0
9	92	0.860	0.860	0.000	0.0
9	91	1.220	1.210	0.010	0.8
9	90	1.190	1.160	0.030	2.5
9	89	1.350	1.320	0.030	2.2
9	88	1.040	1.010	0.030	2.9
9	87	1.350	1.330	0.020	1.5
9	86	1.030	1.030	0.000	0.0
9	85	1.200	1.220	-0.020	-1.7
8	84	0.290	0.300	-0.010	-3.4
8	83	0.290	0.300	-0.010	-3.4
7	82	0.790	0.820	-0.030	-3.8
7	81	1.280	1.300	-0.020	-1.6
7	80	1.190	1.180	0.010	0.8
7	79	1.260	1.240	0.020	1.6
7	78	1.250	1.230	0.020	1.6
7	77	1.200	1.190	0.010	0.8
7	76	1.170	1.160	0.010	0.9
7	75	1.190	1.190	0.000	0.0
7	74	1.170	1.170	0.000	0.0
7	73	1.200	1.190	0.010	0.8
7	72	1.260	1.230	0.030	2.4
7	71	1.270	1.250	0.020	1.6
7	70	1.200	1.180	0.020	1.7
7	69	1.290	1.300	-0.010	-0.8
7	68	0.800	0.820	-0.020	-2.5
6	67	0.430	0.450	-0.020	-4.7
6	66	1.030	1.040	-0.010	-1.0
6	65	1.300	1.300	0.000	0.0
6	64	0.840	0.830	0.010	1.2
6	63	1.310	1.300	0.010	0.8
6	62	1.250	1.230	0.020	1.6
6	61	1.320	1.320	0.000	0.0
6	60	0.980	0.980	0.000	0.0
6	59	1.320	1.310	0.010	0.8
6	58	1.240	1.230	0.010	0.8
6	57	1.310	1.300	0.010	0.8
6	56	0.840	0.830	0.010	1.2
6	55	1.300	1.300	0.000	0.0
6	54	1.030	1.040	-0.010	-1.0
6	53	0.430	0.450	-0.020	-4.7
5	52	0.290	0.300	-0.010	-3.4
5	51	1.050	1.080	-0.030	-2.9
5	50	1.120	1.130	-0.010	-0.9
5	49	1.260	1.250	0.010	0.8
5	48	0.830	0.830	0.000	0.0
5	47	1.260	1.250	0.010	0.8
5	46	1.020	1.010	0.010	1.0
5	45	1.160	1.160	0.000	0.0
5	44	1.010	1.010	0.000	0.0
5	43	1.250	1.240	0.010	0.8
5	42	0.830	0.830	0.000	0.0
5	41	1.250	1.250	0.000	0.0
5	40	1.110	1.120	-0.010	-0.9
5	39	1.050	1.070	-0.020	-1.9
5	38	0.280	0.290	-0.010	-3.6
4	37	0.420	0.440	-0.020	-4.8
4	36	1.140	1.180	-0.040	-3.5
4	35	1.100	1.120	-0.020	-1.8
4	34	1.290	1.300	-0.010	-0.8
4	33	1.180	1.180	0.000	0.0
4	32	1.330	1.330	0.000	0.0
4	31	1.160	1.170	-0.010	-0.9
4	30	1.320	1.330	-0.010	-0.8
4	29	1.170	1.180	-0.010	-0.9
4	28	1.290	1.300	-0.010	-0.8
4	27	1.110	1.130	-0.020	-1.8
4	26	1.140	1.180	-0.040	-3.5
4	25	0.420	0.440	-0.020	-4.8
3	24	0.420	0.440	-0.020	-4.8
3	23	1.040	1.070	-0.030	-2.9
3	22	1.020	1.040	-0.020	-2.0
3	21	1.280	1.300	-0.020	-1.6
3	20	1.020	1.030	-0.010	-1.0
3	19	1.170	1.190	-0.020	-1.7
3	18	1.010	1.030	-0.020	-2.0
3	17	1.270	1.300	-0.030	-2.4
3	16	1.010	1.040	-0.030	-3.0
3	15	1.040	1.080	-0.040	-3.8
3	14	0.420	0.440	-0.020	-4.8
2	13	0.280	0.290	-0.010	-3.6
2	12	0.430	0.450	-0.020	-4.7
2	11	0.790	0.820	-0.030	-3.8
2	10	1.180	1.220	-0.040	-3.4
2	9	1.160	1.190	-0.030	-2.6
2	8	1.180	1.220	-0.040	-3.4
2	7	0.790	0.820	-0.030	-3.8
2	6	0.430	0.450	-0.020	-4.7
2	5	0.290	0.300	-0.010	-3.4
1	4	0.290	0.300	-0.010	-3.4
1	3	0.390	0.410	-0.020	5.1
1	2	0.390	0.410	-0.020	-5.1
1	1	0.290	0.300	-0.010	-3.4

Column letters (left to right): Y, X, W, V, T, S, R, P, N, M, L, K, J, H, G, F, E, D, C, B, A

RMS Deviation: 2.16%

Table 1
Cycle 13 Reload Sub-Batch ID*

Sub-Batch	Number of Assemblies
KY	1
KX	8
N1	8
N2	4
N3	20
N4	20
N5	12
P1	4
P2	4
P3	24
P4	16
P5	20
P6	8
R1	36
R2	20
R3	12

*Reference 6

Table 2
Approach to Criticality

Dilution Rate	Initial Boron Concentration	Final Boron Concentration	Approximate Dilution Time (minutes)
132 gpm	1785	1724	15
88 gpm	1724	1624	60
44 gpm	1624	1573	91

Table 3
CEA Group Worth Summary

CEA Group	Measured Worth (pcm)	Design Worth * (pcm)	Percent Difference
Reference Group B	1965.26	1925	-2.05
3,4&5	1618.36	1534	-5.21
A	1567.00	1484	-5.30
1&2	1591.22	1543	-3.03
Total	6741.84	6486	-3.79

*Reference 6.

Percent difference = (Design - Measured)/(Measured) * 100