

BALTIMORE GAS AND ELECTRIC COMPANY

CALVERT CLIFFS NUCLEAR POWER PLANT

UNIT 1

Docket No. 50-317

License No. DPR-53

SUMMARY OF STARTUP TESTING

FOR FOURTH CYCLE

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SUMMARY OF STARTUP TESTING
FOR
CALVERT CLIFFS UNIT ONE CYCLE FOUR

- I. The following tests were conducted for the Startup of Calvert Cliffs Unit One for Cycle Four. All tests were conducted in a manner similar to initial startup (Ref. 1).
 - A. CEDM/CEA Performance Test
 - B. RCS Flow Verification
 - C. Initial Criticality
 - D. CEA Symmetry Check
 - E. Critical Boron Concentration Measurements
 - F. Isothermal Temperature Coefficient Measurements
 - G. Group Rod Worth Measurements
 - H. Power Coefficient Measurements
 - I. Power Distribution Measurements

- II. The results of these tests and comparison with predictions are as follows:
 - A. The proper functioning of the CEDM's and CEA position indication was verified through insertion and withdrawal of CEA's. All trippable CEA's reached a 90% insertion in less than 3.1 seconds at hot, full flow conditions. The slowest CEA (59) reached 90% insertion in 2.45 seconds.
 - B. Reactor Coolant System flow was verified to be consistent with previous testing.
 - C. Initial Criticality was achieved at 1324 ppm Boron with CEA Group-5 at 68" withdrawn. Predicted value was 1318 ppm.
 - D. The CEA Symmetry Check verified that all CEA's were attached to their extension shafts. An evaluation of the quantitative reactivity change for dual CEA's yielded an azimuthal tilt estimate of $< 4\%$. Acceptance Limit was $\leq 10\%$.
 - E. Critical Boron Measurements - Table 1.

- F. Isothermal Temperature Coefficients - Table 2.
- G. CEA Group Worth Measurements - Table 3.
- H. Power Coefficient Measurements - Table 2.
- I. Power Distribution Measurements - Table 4.

III. All test results were within acceptance limits, except that for the local power distribution measurement made at the 50% power test plateau. The agreement between predicted and measured radial box power distributions met the acceptance criteria of $\pm 10\%$ ($\pm 15\%$ for peripheral assemblies) with the exception of octant assemblies 1 and 2 (Figure 1), where the differences are 10.8% and 11.7% respectively. These differences are the result of several effects relating to the predicted power distributions. The most significant of these effects are:

1. A slight reactivity bias in the calculation of highly irradiated fuel relative to fresh fuel. This causes an underprediction of the power in the core center.
2. Approximations made in the detailed description of the center test assembly. These would cause an underprediction of the power in the core center.
3. Assumptions made in generating the in-core detector coefficients. The coefficients are generated under assumed full power conditions and tend to be less accurate at lower power levels. These effects cause the indicated measured power at the core center to be slightly higher.

All of the assemblies in the full power case (Figure 2) fall within the acceptance criteria. The differences between measurement and prediction observed here are due primarily to the effects described above.

These disparities in the agreement between predicted and measured local power distributions do not obviate the validity of the safety analysis.

TABLE 1
CRITICAL BORON MEASUREMENTS

	<u>Measured</u>	<u>Predicted</u>
All Rods Out, 532°F	1342 ppm	1346 ± 135 ppm
CEA Group 5, 4, 3, 2, 1	1102 ppm	1104 ± 110 ppm

TABLE 2
ISOTHERMAL TEMPERATURE COEFFICIENTS AND POWER COEFFICIENTS

	<u>ITC</u>	
	<u>Measured</u>	<u>Predicted</u>
Zero Power, CEA Group 5 at 105" Withdrawn	+ .36 x 10 ⁻⁴ Δρ/°F	+ .49 ± .3 x 10 ⁻⁴ Δρ/°F
50% Power, CEA Group 5 at 105" Withdrawn	+ .19 x 10 ⁻⁴ Δρ/°F	+ .24 ± .3 x 10 ⁻⁴ Δρ/°F
100% Power, CEA Group 5 at 105" Withdrawn	- .45 x 10 ⁻⁴ Δρ/°F	- .27 ± .3 x 10 ⁻⁴ Δρ/°F
	<u>POWER COEFFICIENT</u>	
50% Power, CEA Group 5 at 105" Withdrawn	-1.08 x 10 ⁻⁴ Δρ/%	- .91 ± .2 x 10 ⁻⁴ Δρ/%
100% Power, CEA Group 5 at 105" Withdrawn	- .89 x 10 ⁻⁴ Δρ/T	- .72 ± .2 x 10 ⁻⁴ Δρ/%

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TABLE 3
CEA GROUP WORTH MEASUREMENTS

	<u>Measured ($\% \Delta \rho$)</u>	<u>Predicted ($\% \Delta \rho$)</u>
Group 5	.550	.586 \pm .088
Group 4	.176	.167 \pm .025
Group 3	.592	.589 \pm .088
Group 2	.460	.451 \pm .068
Group 1	.788	.855 \pm .128
TOTAL	2.567	2.648 \pm .265

TABLE 4
POWER DISTRIBUTION MEASUREMENTS

	<u>Measured</u>		<u>Acceptance Limits</u>	
	<u>50%</u>	<u>100%</u>	<u>50%</u>	<u>100%</u>
F_{xy}^T	1.63	1.50	≤ 1.826	≤ 1.660
F_r^T	1.48	1.45	≤ 1.713	≤ 1.585
T_q	.004	.004	≤ 0.030	≤ 0.030
Radial Box Power Distribution	See Figure 1	See Figure 2	Measurement varies from prediction by less than $\pm 10\%$ ($\pm 15\%$ for fuel assemblies on core periphery).	

FIGURE 1

Calvert Cliffs Unit 1
 Cycle 4, 50% Power
 Comparison of Measured
 Versus
 Predicted Radial Box Power
 Distribution

				17	9
				.693	.892
				.700	.904
				-1.0	-1.3
	32	28	23	16	8
	.733	1.007	1.107	1.105	1.028
	.762	1.052	1.180	1.122	1.074
	-3.8	-4.3	-6.2	-1.5	-4.3
34	31	27	22	15	7
.797	1.206	1.253	1.032	.890	1.130
.838	1.253	1.268	1.048	.881	1.155
-4.9	-3.8	-1.2	-1.6	1.0	-2.2
33	30	26	21	14	6
1.134	1.103	1.061	1.243	.946	.967
1.193	1.110	1.060	1.247	.910	.923
-4.9	-.6	.1	.3	4.0	4.8
	29	25	20	13	5
	1.025	1.031	.944	1.011	.888
	1.047	.994	.917	.974	.843
	-2.1	3.7	2.9	3.8	5.3
		24	19	12	4
		.954	1.097	.812	1.053
		.944	1.069	.796	.995
		1.0	2.6	2.0	5.8
			18	11	3
			.854	1.086	.844
			.820	1.018	.790
			4.1	6.7	6.8
				10	2
				.984	1.089
				.910	.975
				8.1	11.7
					1
					.614
					.554
					10.8

Measured
 Predicted
 % Diff

50%, 13.4 MWD/T

50%, 13.4 MWD/T

$$\frac{\text{Measured} - \text{Predicted}}{\text{Predicted}} \times 100$$

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FIGURE 2

Calvert Cliffs Unit 1
 Cycle 4, 100% Power
 Comparison of Measured
 Versus
 Predicted Radial Box Power
 Distribution

t Cliffs Unit 1						17	.672	9	.854	
4, 100% Power										
ison of Measured							.665		.859	
Versus							1.1		-.6	
ted Radial Box Power										
bution										
	32	.695	28	.954	23	1.068	16	1.085	8	1.043
		.717		.980		1.109		1.084		1.057
		-3.1		-2.7		-3.7		.1		-1.3
34	31	1.165	27	1.197	22	1.007	15	.901	7	1.228
		1.193		1.203		1.023		.898		1.212
		-2.3		-.5		-1.6		.3		1.3
	33	1.173	30	1.078	26	1.042	14	.960	6	.992
		1.205		1.098		1.049		.939		.966
		-2.7		-1.8		1.1		2.2		2.7
	29	1.032	25	1.041	20	.952	13	1.031	5	.905
		1.056		1.012		.943		1.011		.888
		-2.3		2.9		1.0		2.0		1.7
			24	.969	19	1.123	12	.844	4	1.095
				.973		1.103		.845		1.047
				-.4		1.8		-.1		4.8
					18	.878	11	1.125	3	.881
						.869		1.077		.853
						1.0		4.5		3.3
							10	1.035	2	1.163
								.985		1.068
								5.1		8.9
									1	.734
										.687
										6.8

Measured

Predicted

% Diff

99.6%, 1043 MWD/T

99.6%, 1043 MWD/T

Measured - Predicted

Predicted

 x 100

Measured
 Predicted
 % Diff

99.6%, 1043 MWD/T
 99.6%, 1043 MWD/T
 $\frac{\text{Measured} - \text{Predicted}}{\text{Predicted}} \times 100$

REFERENCES

1. Calvert Cliffs Nuclear Power Plant Unit 1, Startup Test Report,
August 29, 1975.

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