DUQUESNE LIGHT COMPANY

Beaver Valley Unit No. 1

STARTUP PHYSICS TEST REPORT

September, 1983

Beaver Valley Power Station
Cycle 4 Startup Test Report

INTRODUCTION:

This report describes the startup tests program applicable for the Cycle 4 reload core design verification and recalibration of the excore instrumentation for Beaver Valley Power Station, Unit 1. This testing program consisted of the following measurements:

1. Control rod drop time measurements.
2. Critical boron concentration measurements.
3. Control rod bank worth measurements.
4. Temperature coefficient measurements.
5. Reactivity computer checks.
6. Excore calibration.
7. Startup power distribution measurements using the incore flux mapping system.

The results of these startup tests are summarized in this report and comparisons are made to predicted design values and applicable BVPS technical specification requirements.

TEST SUMMARY:

Prior to initial criticality and the performance of the low power physics testing, the drop times of each full length Rod Cluster Control Assembly (RCCA) were measured at both cold no RCS flow and hot full RCS flow plant conditions. The drop times of all 48 rods were well within the BVPS Technical Specification requirement of ≤ 2.2 seconds from beginning of rod drop to dash pot entry, with the slowest time being 1.40 seconds for rod B-6 at hot full RCS flow.

The initial criticality for Cycle 4 reload core was achieved at 2217 hours on September 22, 1983. Following the completion of initial criticality the testing decade for low power physics was established and the reactivity computer was checked using the reactor. Low power physics testing (LPPT) was then initiated.

BORON ENDPOINT:

The all rods out (ARO) critical boron concentration was measured to be 1469.5 ppm. This value was well within the design prediction of 1466 $\pm$ 50 ppm.

TEMPERATURE COEFFICIENTS:

The isothermal temperature coefficient (ITC) and moderator temperature coefficient (MTC) were measured at the all rods out configuration. The average measured ITC was determined to be -2.15 pcm/°F which is within the acceptance criteria of -2.2 ± 3 pcm/°F. Subtracting the predicted design value of the doppler coefficient (-2.1 pcm/°F) from the measured ITC, the MTC was calculated to be -0.05 pcm/°F. This value for the moderator temperature coefficient meets the requirements of BVPS Technical Specification 3.1.1.4, which requires a negative MTC to ensure that the assumptions used in the accident and transient analyses are valid.

LOW POWER FULL CORE FLUX MAPS:

A full core flux map was taken at the ARO configuration to determine the initial flux distribution in the core during LPPT. Table I lists the values for quadrant power tilt, nuclear enthalpy hot channel factor ($F^N_{\Delta H}$), and maximum deviations from predicted relative assembly powers.

Due to the quadrant power tilt, both relative assembly power and $F^N_{\Delta H}$ exceeded their acceptance criteria for the test in the region of the core that the power tilt occurred. Based on Westinghouse's position statement regarding core tilts measured at zero power and the fact that all measured peaking factors were within their applicable technical specification limits, an additional full core flux map was performed at 47% power to reverify the quadrant power tilt and core peaking factors.

AT POWER FULL CORE FLUX MAPS:

Full core flux maps were performed at 47%, 72% and 99% power to check core design predictions. The results from these maps were all well within the acceptance criteria and applicable Technical Specifications as illustrated in Table I.

RCC BANK WORTHS BY ROD SWAP:

The worth of the reference bank for rod swap, CBB, was measured using the boron dilution method. Following the insertion of CBB, the worths of the remaining control and shutdown banks were obtained relative to CBB. The measured worth, predicted value, and the percent difference for each RCC bank and total RCC worth are listed in Table II. All the measured values were within the acceptance criteria for the test.

REACTIVITY COMPUTER

The reactivity computer was checked prior to LPPT, every 24 hours during testing, and at the end of LPPT using the exponential generator. In addition, the reactivity computer was checked against the reactor following initial criticality. In all cases the computer error was within the 4% acceptance criteria.

INCORE - EXCORE AXIAL OFFSET CALIBRATION:

At 73% power, a full core flux map and five quarter-core flux maps were taken to calibrate the excore detectors in accordance with BVT 1.3-2.2.3. The maps were taken at various axial offsets (from +2.021% to -11.29%) to provide a wide span of data points for the calibration. The full core flux map taken at 99% power verified the calibration performed at 73% power and also served as a further check on core peaking factors.

TABLE I

FULL CORE FLUX MAPS

	ARO-HZP	50% Power CBD = 177 steps	100% Power ARO	Acceptance Criteria
Quadrant Tilt	1.0309	1.01	1.0051	< 1.02 (Tech. Spec. < 1.02 above 50% power)
Maximum Deviation from Predicted Relative Assembly Powers	14.873%	5.917%	3.705%	± 10% of Predicted for Relative Powers >.9
	15.188%	5.921%	3.705%	± 15% of Predicted for Relative Powers ≤.9
$F^N_{\Delta H}$	1.695	1.49	1.4273	1.43 ± .14 ARO-HZP Tech. Spec.: <2.015 for HZP <1.795 for 47% <1.555 for 99%

TABLE II

RCC BANK WORTHS

RCC Bank	Measured Value (pcm)	Predicted Value (pcm)	Error (%)	Acceptance Criteria
CBB*	1432.70	1404	2.04	± 10%
CBD	1065.68	1125	-5.27	± 15%
CBC	820.71	854	-3.90	± 15%
CBA	602.21	561	7.35	± 15%
SBB	915.03	1017	-10.03	± 15%
SBA	1173.08	1123	4.46	± 15%
Total Worth	6009.41	6084	-1.23	± 10%

* Reference Bank