Beaver Valley Power Station
Cycle 3 Startup Test Report

INTRODUCTION:

This report describes the startup testing program applicable for the Cycle 3 reload core design verification and experimental evaluation of the shutdown capability of the Rod Cluster Control (RCC) banks prior to power escalation of the 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. Power coefficient measurements.
6. Startup power distribution measurements using the incore flux mapping system.

The results of the various startup and low power physics tests are summarized in this report and comparisons are made to predicted design values and applicable BVPS technical specification requirements.

TEST SUMMARY:

Prior to the performance of the initial criticality and low power physics tests, the drop times of each full length Rod Cluster Control Assembly (RCCA) was measured both at 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 the beginning of rod drop to dashpot entry.

The initial criticality for Cycle 3 reload core was achieved at 0243 hours on July 7, 1982. Following the completion of initial criticality, the testing decade for low power physics was established and the reactivity computer checked out. Low power physics testing (LPPT) was then initiated.

ISOTHERMAL TEMPERATURE COEFFICIENT:

Two (2) separate measurements of the Isothermal Temperature Coefficient were made during LPPT: the first at ARO and the second with all rods out except Control Bank D (CBD) at zero (0) steps. The values obtained were within BVPS test acceptance criteria; and are shown in Table 1.

Using the average ARO Isothermal coefficient and the predicted design value of the doppler coefficient, (2.0 pcm/°F) the moderator temperature coefficient (MTC) is found to be positive .255 pcm/°F. Because this is a positive number, it does not meet the requirements of BVPS Technical Specification No. 3.1.1.4, which requires a negative MTC to ensure that the assumption used in the accident and transient analyses are valid. To meet this requirement, the MTC was maintained negative, during critical operation, by administrative control over the allowable maximum coolant boron concentration.

LOW POWER FULL CORE FLUX MAPS:

Full Core Flux Maps were taken during ARO configuation and with all rods out except CBD in to determine the initial flux distribution in the core during LPPT. Values for quadrant tilts, nuclear enthalpy hot channel factor ($F^N_{\Delta H}$), and maximum deviations from predicted for relative assembly powers are listed in Table II.

All quantities are within acceptance criteria and well below technical specification limits with the exception of the quadrant power tilt ratio and the deviation from predicted relative assembly power.

The off normal values were discussed with the fuel vendor and it was decided to perform additional measurements at a higher power level. Table II lists the additional data as measured at the power level of approximately 45 percent. As can be seen, the quadrant power tilt ratio and the deviations from the Predicted Relative Assembly Powers are all within their acceptance criteria and well within the limits of the Technical Specifications.

BORON ENDPOINT CONCENTRATION:

Table III lists the Boron Endpoint Measurements of each Control Bank along with the predicted values. Using the predicted values based on actual Cycle 2 Burn-Up, all the measured Boron Endpoints are within the acceptance criteria.

BANK WORTHS BY BORON DILUTION:

Control Bank Worths were obtained using the Boron Dilution Method. The values in pcm for Control Rod Banks A, B, C and D, and the total worth of all Control Banks are listed with the predicted values, and the percent difference, in Table IV. All the measured values were within the acceptable limit.

REACTIVITY COMPUTER:

The Reactivity Computer was checked just before LPPT as part of the Initial Criticality Test, every 24 hours and at the end of LPPT. In all cases the computer was within acceptable limits.

INCORE-EXCORE AXIAL OFFSET DETECTOR CALIBRATION:

With the LPPT completed, a series of full core flux maps were taken at approximately 75% and 100% full power for the purpose of Incore-Excore Detector Calibration. All values obtained from these flux maps met all the requirements of BVPS Technical Specifications.

POWER COEFFICIENT MEASUREMENT:

The power coefficient was measured during a decreasing and an increasing reactor load change of 10%. The power coefficient, including Xenon change corrections, was determined to be -16.03 pcm per % power. This value is within the allowable tolerance of -9.38 to -18.07 pcm per % power of the design predictions.

TABLE 1

ISOTHERMAL TEMPERATURE COEFFICIENT (ITC)

	Average Measured Value	Acceptance Criteria
ARO	-1.745 pcm/°F	-3.0 ± 3.0
ARO except CBD in	-4.37 pcm/°F	-5.9 ± 3.0

TABLE II

FULL CORE FLUX MAPS

	ARO Measured Value	ARO Except CBD in Measured Value	ARO at 45% Power Measured Value	Acceptance Criteria
Quadrant Tilt	1.048	1.0488	1.0108	1.02
$F^N_{\Delta H}$	1.5057	1.8019	1.4021	1.46 ± .15 for ARO 1.78 ± .18 for ARO Except CBD In
Maximum Deviation From Predicted Relative Assembly Powers	12.673%	-11.143%	9.282%	± 10% of Incore For Relative Powers $\geq$ .9
Maximum Deviation From Predicted Relative Assembly Powers	12.569%	12.837%	11.283%	± 15% of Incore For Relative Powers < .9

TABLE III

BORON ENDPOINT CONCENTRATIONS

Bank Configuration	Measured Values (ppm)	Acceptance Criteria (ppm)
ARO	1496.73	1467 ± 50
CBD In	1361.96	1337 ± 50
CBD & C In	1254.31	1233 ± 50
CBD & C & B In	1104.3	N/A
CBD & C & B & A In	949.03	N/A

TABLE IV

BANK WORTHS

RCC Bank	Measured Value (pcm)	Predicted Value (Pcm)	Error %
CBD	1135.26	1199	-5.32
CBC	990.0	973	+1.75
CBB	1305.1	1421	-8.16
CBA	1504.2	1514	-0.65
Total Worth	4934.56	5107	+3.38