Duquesne Light Company Beaver Valley Power Station
P.O. Box 4
Shippingport, PA 15077-0004

JOHN D. SIEBER
Vice President - Nuclear Group

(412) 393-5255

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

Reference: Beaver Valley Power Station, Unit No. 1
Docket No. 50-334, License No. DPR-66
Cycle 8 Startup Test Report

Gentlemen:

Enclosed is a copy of the Cycle 8 Startup Test Report provided in accordance with Technical Specification 6.9.1.3 Item (2). This report summarizes the applicable physics testing performed to verify the adequacy of the Cycle 8 reload core design. The results of each test performed indicated that the measured parameters were within the specified acceptance criteria.

Very truly yours,

J. D. Sieber
Vice President
Nuclear Group

Enclosure

cc: Mr. J. Beall, Sr. Resident Inspector
Mr. W. T. Russell, NRC Region I Administrator
Mr. P. Tam, Sr. Project Manager

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DUQUESNE LIGHT COMPANY

BEAVER VALLEY POWER STATION

UNIT 1

CYCLE 8

STARTUP PHYSICS TEST REPORT

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Prepared by: D. A. Moul

D. A. Moul
Core Performance Engineer

Reviewed by: T. G. Zyra

T. G. Zyra
Testing and Plant
Performance Director

Reviewed by: R. J. Druga

R. J. Druga
Technical Services Manager

Approved by: T. P. Noonan

T. P. Noonan
General Manager
Nuclear Operations

BEAVER VALLEY POWER STATION

Cycle 8 Startup Test Report

INTRODUCTION:

Beaver Valley Unit 1 was shutdown on September 1, 1989 for its Seventh Refueling Outage. During the outage, 68 of 157 fuel assemblies were replaced with a split batch: 16 fuel assemblies of 3.60 w/o enrichment and 52 fuel assemblies of 4.00 w/o enrichment. The fresh fuel rods are based on the Vantage 5H design with natural uranium in the top and bottom six inches. Assemblies with Integral Fuel Burnable Absorbers (IFBA) have arrangements of 64, 100, or 160 rods with boride-coated pellets in the central 120 inches. A region of unpoisoned fuel six inches in length is found between the natural uranium and the boride-coated fuel in these IFBA fuel assemblies.

This report describes the startup test program applicable for the Cycle 8 reload core design verification for BVPS, Unit 1. This testing program consisted of the following measurements conducted from December 20, 1989 through January 12, 1990:

1. Control rod drop time
2. Initial criticality
3. Boron endpoints
4. Control bank worths
5. Temperature coefficient
6. Reactivity computer checks
7. 30% power symmetry check
8. Incore/Excore cross-calibration
9. Power distribution measurements at 75% and 100% reactor power.

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 SUMMARIES:

1BVT 1.1.1, "Control Rod Drop Time Measurements"

PURPOSE:

The purpose of this test was to determine a drop time for each full-length Rod Cluster Assembly with the RCS in Hot Standby, Tavg ≥ 541°F, and full RCS flow.

TEST DESCRIPTION:

A single RCCA Bank is withdrawn to the full-out position (228 steps). A visicorder is connected to the detector primary coil and test leads are then inserted at the stationary gripper coil jacks in the power cabinets. The RCCA blown fuse indicator and moving coil fuse are removed. After the visicorder is turned ON, an assembly is dropped by pulling the stationary gripper fuse out. Each of the 48 rod cluster assemblies is tested in this manner and the drop times are determined from the start of stationary gripper voltage decay to dashpot entry on the visicorder traces.

RESULTS:

The test was started at 1321 on December 20, 1989 and completed at 0449 on December 21, 1989. The drop times of all 48 rods were well within the BVPS Technical Specification Requirement of < 2.7 seconds, with slowest time being 1.85 seconds for rod K-14 at hot full RCS flow.

1BVT 2.2.1, "Initial Approach to Criticality"

PURPOSE:

The purpose of this test was to: (1) achieve initial criticality; (2) determine the point at which nuclear heat occurs and establish the Zero Power Physics Testing Band (ZPPTB); (3) verify the proper calibration of the reactivity computer.

TEST DESCRIPTION:

Initial conditions were established with shutdown banks fully withdrawn, control banks fully inserted, boron concentration 2004 ppm, RCS temperature at 547°F and RCS pressure at 2235 psig on December 24, 1989 at 1859.

The control banks were withdrawn in 50 step intervals until Control Bank D reached 160 steps. An Inverse Count Rate Ratio (ICRR) was taken at each interval. During control rod withdrawal, the ICRR dropped from 1.0 to approximately 0.35.

Dilution to criticality commenced at 2045 at a rate of approximately 500 pcm/hr. Again, the ICRR was monitored and plotted at 20 minute intervals. At 0216 on December 25, 1989 after 8,069 gallons had been added criticality was achieved.

Following the recording of criticality data, flux was increased toward nuclear heat. Nuclear heat occurred at 3.4×10^{-7} amps as indicated on the reactivity computer strip chart recorder by increasing Tavg and/or an expontential decay of the reactivity trace.

A reactivity computer operational checkout was then performed using the reactor with positive reactivity insertions of 29.0 pcm, 33.8 pcm, and 57.2 pcm as indicated by the reactivity computer. The doubling times were also measured and reactor period calculated. The calculated period was then input to the Westinghouse Nuclear Design Report computer program which provided predicted reactivity values based on the reactor period. Predicted reactivity was compared to measured for each insertion. 1BVT 2.2.1 was completed at 0706 on December 25, 1989.

RESULTS:

The All Rods Out (ARO) critical boron concentration corrected for rod position was calculated to be 1695 ppm which was outside the acceptance criteria of 1752 ± 50 ppm. Westinghouse was contacted and reviewed the Cycle 8 Reload Safety Analysis Checklist (RSAC) parameters. Based on this review, it was determined that a 57 ppm deviation from the design value would not significantly affect the RSAC analysis since overprediction of critical boron is generally conservative, resulting in a more negative moderator temperature coefficient. A field revision to the test was written referencing the Westinghouse analysis and approved by the station to change the acceptance criteria to 1752 ± 75 ppm.

The Zero Power Physics Test Band (ZPPTB) was set at 9.0×10^{-9} amps to 3×10^{-8} amps based on remaining a decade below the measured nuclear heating point of 3.4×10^{-7} amps and remaining a decade above the background current reading of 9.0×10^{-10} amps on the power range detectors.

All the test runs for the reactivity computer were within the acceptance criteria of 4%. The errors for the three test cases were 0.0%, 0.2%, and 1.5%.

1BVT 2.2.2, "Core Design Check Test"

PURPOSE:

The purpose of this test was to verify the reactor core design from hot zero power to 100 percent reactor power, and to perform the incore/excore cross-calibration.

TEST DESCRIPTION:

The test was divided into five parts:

Section A covered zero power physics tests. These tests included boron endpoint measurements, boron dilution worth measurement of the reference bank (CBB), rod swap bank worths, differential boron worth, and an isothermal temperature coefficient measurement.

Section B involved verifying core symmetry and proper core loading by performing a full-core flux map prior to exceeding 30% reactor power.

Section C required a full-core flux map to be obtained prior to exceeding 75% reactor power to ensure the measured peaking factors were within their applicable Technical Specification Limits.

Section D required an incore/excore calibration between 50% and 100% of rated thermal power. This involved performing 1BVT 2.2.3, "Nuclear Power Range Calibration", in which a series of flux maps are run at various axial offsets.

Finally, Section E involved performing a full-core flux map at 100% reactor power. This map served as a calibration check for the incore/excore calibration and verified that the power distribution limits of the Technical Specifications were not exceeded.

RESULTS:

Boron Endpoint:

The All Rods Out (ARO) critical boron concentration was measured to be 1688 ppm at 0854 on December 25, 1989, which was outside the acceptance criteria of 1752 ± 50 ppm. Based on the results of 1BVT 2.2.1, "Initial Approach to Criticality", the ARO critical boron concentration was expected to be outside the ± 50 ppm limit. Westinghouse was contacted during 1BVT 2.2.1 and reviewed the Cycle 8 RSAC. Based on the Westinghouse reanalysis, a field revision to the test was incorporated to change the acceptance criteria to 1752 ± 75 ppm.

The Control Bank D-in critical boron concentration was measured to be 1542 ppm at 1535 on December 25, 1989, which was within the acceptance criteria of 1591 ppm ± 15%.

Temperature Coefficient:

The ARO, HZP Isothermal Temperature Coefficient (ITC) was measured at 1057 on December 25, 1989. The average ITC was determined to be -2.75 pcm/°F which was within the acceptance criteria of -2.50 ± 3 pcm/°F.

Subtracting out the predicted design value of the doppler coefficient (-2.00 pcm/°F) from the measured ITC, the MTC was calculated to be -0.75 pcm/°F. This value meets the requirements of BVPS Technical Specifications which require the MTC to be between -50 pcm/°F and 0 pcm/°F. The station has in place procedures to ensure that a negative MTC is maintained throughout Cycle 8 core life.

Differential Boron Worth:

The measured differential boron worth was 7.43 pcm/ppm. This value was within the acceptance criteria of 7.35 pcm/ppm ± 15%.

RCC Bank Worths:

The boron dilution measurement of the reference bank for rod swap, CBD, was completed at 1535 on December 25, 1989. Following the insertion of CBD, the worths of the remaining control and shutdown banks were obtained relative to CBD on December 25, 1989 between 1550 and 1837. The measured worth, predicted value, and percent difference for each RCC bank and total RCC worth are listed in Table 1. All the measured values were within the acceptance criteria for this test.

Reactivity Computer:

The reactivity computer was checked prior to Low Power Physics Testing (LPPT), every 24 hours during testing, and at the conclusion of LPPT using the exponential generator. In addition, the reactivity computer was checked using the reactor following initial criticality. In all cases, the computer error was within the 4% acceptance criteria, with the highest measured error being 1.5%.

30 Percent Power Symmetry Check:

A full-core flux map was performed on December 30, 1989 at approximately 30% reactor power with CBD at 175 steps to determine the initial flux distribution in the core. Table 2 lists the values for quadrant tilt and maximum deviation from predicted assembly powers for the 30% flux map. All measured values were within the acceptance criteria for the test.

75 Percent Power Flux Map and Incore/Excore Calibration:

On January 3, 1990 1BVT 2.2.3, "Nuclear Power Range Calibration", was performed at approximately 75% power. This test involved a full-core and six quarter-core flux maps obtained at various axial offsets to calibrate the excore detectors and verify core peaking factors. The results of the full-core flux map are shown in Table 2. All measured values are within the acceptance criteria. The measured Fxy corrected for uncertainties was 1.6767 for the 75% flux map. The Technical Specifications require that this value be less than Fxy(RTP) (1.71) and Fxy(LIM) (1.8077 for 75% power). This requirement was met.

100 Percent Power Flux Map:

On January 12, 1990 a full-core flux map was performed at 100% power. This map served as a check for the incore/excore calibration and power distribution limits. The measured Fxy with uncertainties was 1.6325 which was below Fxy (RTP) by 4.5% and Fxy (LIM) by 4.6%. The results of the map are shown in Table 2.

The 100% flux map marked the completion of the reload startup test program for Beaver Valley Power Station, Unit 1, Cycle 8.

TABLE 1

CONTROL ROD BANK WORTHS

Bank	Measured Value (pcm)	Predicted Value (pcm)	Error (%)	Acceptance Criteria
CBD*	1084.6	1183	-8.3	± 10%
CBC	810.8	863	-6.0	± 15%
CBB	986.8	1087	-9.2	± 15%
CBA	736.3	750	-1.8	± 15%
SBB	750.0	828	-9.4	± 15%
SBA	1057.0	1148	-7.9	± 15%
Total Worth	5425.5	5859	-7.4	± 10%

* Reference Bank for Rod Swap.

TABLE 2

FULL CORE FLUX MAPS

Parameters	30% Power CBD 175 steps	75% Power CBD 190 steps	100% Power CBD 225 steps	Acceptance Criteria
Quardrant Tilt	1.0088	1.0067	1.0044	≤1.02 for power above 50%
Maximum Deviation from Predicted Assembly Powers	4.1%	4.4%	2.6%	± 10% for Predicted Power > .9
F delta H	N/A	1.5367	1.4879	Tech. Spec.: < 1.7589 for 75% < 1.6228 for 100%
Fxy	N/A	1.6767	1.5325	Tech. Spec.: < 1.8077 for 75% < 1.7120 for 100% Fxy(RTP)=1.71