DUQUESNE LIGHT COMPANY

Beaver Valley Power Station

Unit No. 1

CYCLE 5

STARTUP PHYSICS TEST REPORT

January 1985

BEAVER VALLEY POWER STATION

Cycle 5 Startup Test Report

INTRODUCTION:

This report describes the startup test program applicable for the Cycle 5 reload core design verification and incore/excore cross-calibration for Beaver Valley Power Station, Unit I. 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. Incore/Excore cross-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 SUMMARIES:

BVT 1.1 - 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, T avg $\geq$ 541° F, and full reactor coolant system 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A single RCCA Bank is withdrawn to the full-out position (228 steps).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 determined from the visicorder traces.

RESULTS:

The drop times of all 48 rods were well within the BVPS Technical Specification requirement of $\leq$ 2.2 seconds, with the slowest time being 1.44 seconds for rod B-6 at hot full RCS flow.

BVT 1.5 - 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 decade; (3) verify the proper calibration of the reactivity computer.

TEST DESCRIPTION

Initial conditions were established with the shutdown banks fully withdrawn, control banks fully inserted, boron concentration 1940 ppm, RCS temperature at 547°F and RCS pressure at 2235 psig.

The control banks were withdrawn in 50 step intervals until control bank D reached 160 steps.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 0.41.

Dilution to criticality was then commenced at approximately 1000 pcm/hr. Again, ICRR was monitored and plotted at 20 minute intervals. At 0200 on January 2, 1985 after 12,400 gallons had been added criticality was achieved.

Following the recording of criticality data, power was increased toward nuclear heat. Nuclear heat occurred at 7.4×10^{-7} amps as indicated on the reactivity computer. The zero power physics testing decade (ZPPTD) was set from 3×10^{-9} amps to 3×10^{-8} amps on the reactivity computer.

Flux was then reduced to the lower end of the ZPPTD in preparation for the reactivity computer operational checkout. Positive reactivity insertions of 25 pcm, 32 pcm, and 45 pcm were made with the reactor doubling times being measured for each. The results were checked against Westinghouse design criteria.

RESULTS:

The all rods out (ARO) critical boron concentration corrected for rod position was calculated to be 1566.5 ppm. The acceptance criteria was 1525 $\pm$ 50 ppm. Thus the measured value was within the acceptance criteria.

The ZPPTD was set at 3×10^{-9} amps to 3×10^{-8} amps based on a measured nuclear heat point of 7.4×10^{-7} amps.

All the test runs for the reactivity computer showed good agreement with design data. The errors for the three test cases were 1.82%, 0.25%, and 1.22%, all well within the 4% acceptance criteria.

BVT 1.5 - 2.2.2 Core Design Check Test

PURPOSE:

The purpose of this test was to verify the reactor core design data between 0 and 100 percent power, and to perform the incore/excore cross-calibration prior to 75% reactor power.

TEST DESCRIPTION:

The test was divided into three 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, and isothermal temperature coefficient measurements. Core power anomalies were also checked at this time by performing an ARO zero power full-core flux map.

Section B involved incore/excore cross-calibration prior to exceeding 75% of rated thermal power. This involved performing BVT 1.3 - 2.2.3 Nuclear Power Range Calibration, in which a series of flux maps are run at various axial offsets. The flux maps were also examined to ensure that the measured peaking factors were within their applicable Technical Specification limits.

Section C required a full-core flux map to be run at 100% power to serve as a calibration check for the incore/excore calibration and to verify that the measured peaking factors were within the power distribution limits of applicable Technical Specifications.

RESULTS:

Boron Endpoints

The all rods out (ARO) critical boron concentration was measured to be 1576 ppm. This value was 1 ppm outside the acceptance criteria of 1525 ± 50 ppm. Westinghouse was contacted and responded that the 50 ppm criteria was considered a design review criteria and that there were no safety or technical specification implications. Hence the plant could proceed to Mode 1.

Westinghouse then recalculated the HZP, ARO critical boron concentration taking actual EOC-4, as built data and redistribution effects into account. The updated calculations yielded a predicted value of 1546 ppm ± 50 ppm. Thus, the 1576 ppm measured value was within the updated acceptance criteria band.

The Control Bank B-in critical boron concentration was measured to be 1420 ppm, which was within the acceptance criteria of 1399 ppm ± 15%.

Temperature Coefficients

The isothermal temperature coefficient (ITC) and moderator temperature coefficient (MTC) were measured at ARO, HZP conditions. The average measured ITC was determined to be -2.66 pcm/°F which was within the acceptance criteria of -2.1 ± 3 pcm/°F. Subtracting the predicted design value of the doppler coefficient (-2.0 pcm/°F) from the mesured ITC, the MTC was calculated to be -0.66 pcm/°F. This value for the MTC meets the requirements of BVPS Technical Specifications which requires the MTC to be between -50 pcm/°F and 0 pcm/°F.

Inverse Boron Worth

The measured inverse boron worth was 0.117 ppm/pcm. This value was outside the acceptance criteria of 0.092 ppm/pcm ± 15%. Utilizing the revised ARO critical boron of 1546 ppm, the acceptance criteria was

revised to 0.1078 ppm/pcm ± 15%. Thus, the measured value was within the updated design value.

RCC Bank Worths

The worth of the reference bank for rod swap, CBB, was measured using boron dilution. 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 percent difference for each RCC bank and total RCC worth are listed in Table I. 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 with the reactor following initial criticality. In all cases the computer error was within the 4% acceptance criteria, with the highest measured error being 1.82%.

Low Power Full Core Flux Map

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

Due to the slight core tilt measured during the HZP map, an additional map was performed at 50% power to reverify the core tilt. All other measured values were within the zero power map acceptance criteria.

At Power Full Core Flux Maps

Full core flux maps were performed at 53%, 59% and 99% power to check core design predictions and applicable Technical Specifications for core peaking factors. The results from these maps were all well within the Technical Specifications for BVPS Unit I, as illustrated in Table II.

Incore/Excore Axial Offset Calibration

At 59% power, a full-core flux map and seven quarter-core flux maps were performed at various axial offsets to calibrate the excore detectors in accordance with BVT 1.3 - 2.2.3, Nuclear Power Range Calibration. Upon reaching 100% power a full-core map was performed to check the incore/excore calibration. Due to the relatively high error found during this check (close to 3%), BVT 1.3 - 2.2.3 was performed

again at 100% reactor power. A full-core and six quarter-core flux maps were utilized to recalibrate the detectors at full power.

TABLE I

RCC BANK WORTHS

RCC Bank	Measured Value (pcm)	Predicted Value (pcm)	Error (%)	Acceptance Criteria
CBB*	1334.8	1363	-2.1	± 10%
CBD	920.5	1004	-8.3	± 15%
CBC	996.6	992	.5	± 15%
CBA	589.5	604	-2.4	± 15%
SBB	905.7	939	-3.5	± 15%
SBA	1029.3	1089	-5.5	± 15%
TOTAL WORTH	5776.4	5991	-3.6	± 10%

* Reference Bank

TABLE II

FULL CORE FLUX MAPS

	ARO-HZP	50% Power CBD=187 steps	100% Power ARO	Acceptance Criteria
Quadrant Tilt	1.0208	1.0132	1.0040	$\leq$ 1.02 (Tech. Spec. is $\leq$ 1.02 above 50% power)
Maximum Deviation from Predicted Assembly Powers	8.8%	5.4%	4.2%	$\pm$ 10% of Predicted for Relative Power > .9
	12.8%	5.1%	7.8%	$\pm$ 15% of Predicted for Relative Powers $\leq$ .9
$F^N_{\Delta H}$	* 1.4851 1.5445	1.4456	1.3935	* 1.38 $\pm$ .14 ARO-HZP Tech Spec.: < 2.02 for HZP < 1.77 for 53% < 1.55 for 99%
F_Q	2.3811	1.9195	1.7505	Tech. Spec.: < 4.5124 for HZP < 4.3262 for 53% < 2.3474 for 99%

* Does not include uncertainties

Duquesne Light

Nuclear Group
P.O. Box 4
Shippingport, PA 15077-0004

Telephone (412) 393-6000

March 12, 1985

United States Nuclear Regulatory Commission
Director of Nuclear Reactor Regulation
ATTN: Mr. Steven A. Varga
Operating Reactors Branch No. 1
Division of Licensing
Washington, D.C. 20555

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

Gentlemen:

Enclosed is the Cycle 5 Beaver Valley Startup Test Report, submitted in accordance with Technical Specification 6.9.1.3. The report provides a technical summary of the BVPS, Unit No. 1 Startup Testing Program. Comparisons are made to predicted design values and applicable Beaver Valley Power Station Technical Specification requirements.

Very truly yours,

T. D. Jones, General Manager
Nuclear Operations Unit

Attachment

cc: Mr. W. M. Troskoski, Resident Inspector
U.S. Nuclear Regulatory Commission
Beaver Valley Power Station
Shippingport, PA 15077

U. S. Nuclear Regulatory Commission
c/o Document Management Branch
Washington, D.C. 20555

Director, Safety Evaluation & Control
Virginia Electric & Power Company
P. O. Box 26666
One James River Plaza
Richmond, VA 23261

IE26
1/1