DRESDEN UNIT 3 CYCLE 15
STARTUP TEST REPORT

Table of Contents

Startup Testing Summary

Dresden Unit 3 resumed commercial operation for Cycle 15 on June 20, 1997, following a scheduled refueling and maintenance outage. The reload fuel for Cycle 15 is comprised of 232 Siemens Power Corporation (SPC) manufactured ATRIUM-9B fuel assemblies. The D3C15 reload is the first reload of ATRIUM fuel for Dresden Station and the second reload of liner fuel in Unit 3.

The startup test program was similar to those performed for previous Unit 2 and Unit 3 beginning-of-cycle startups at Dresden. Various physics tests were performed (ie., shutdown margin, critical eigenvalue comparison) as well as instrument calibrations (ie., LPRM, TIP, flow instrumentation) as addressed by the Technical Specifications, the Rebaselined Updated Final Safety Analysis Report, and previous commitments to the Nuclear Regulatory Commission. No unusual conditions were noted during the performance of these tests and results were as expected.

Startup Test No. 1 - Core Verification and Audit

Purpose

The purpose of this test is to visually verify that the fuel is correctly positioned and oriented in the reactor core.

Acceptance Criteria

The as-loaded core must conform to the reference core design used in the licensing analyses. At least one independent party must either participate in the performance of the core verification or review a video recording of the core verification prior to unit startup. Any discrepancies discovered in the loading must be promptly corrected and the affected areas reverified to insure proper core loading prior to unit startup. Conformance to the reference core design will be documented by a permanent core serial number map signed by the audit participants.

Results and Discussion

The Cycle 15 core verification consisted of a core height check performed by the Fuel Handling Department and two video-taped passes over the core viewed by the Station Nuclear Group. The purpose of the height check was to verify proper seating of each fuel bundle in its fuel support piece. The video-taped passes over the core allowed verification of proper assembly orientation and location. On May 27, 1997, the final core verification was completed per DTS 8474.(1) The core was verified as being properly loaded and consistent with the Unit 3 Cycle 15 core reload designed by the Nuclear Fuel Services Department of ComEd. Therefore, the as-loaded core configuration is consistent with that assumed in the evaluation of the Dresden Unit 3 Cycle 15 Reload Licensing Analyses.

Startup Test No. 2 - Control Rod Operability and Subcriticality Check

Purpose

The purpose of this test is three-fold. First, it insures that no gross local reactivity irregularities exist. Second, it allows verification that each control rod is latched to its control rod drive. Finally, it insures that all control rods and control rod drives are functioning properly.

Acceptance Criteria

The following conditions must be met:

1. After the core is fully loaded, the strongest worth control rod will be withdrawn to insure that criticality will not occur. As it is withdrawn, nuclear instrumentation will be monitored to verify subcriticality.
2. Each control rod drive will be withdrawn and then checked for overtravel to verify coupling. The control rod drive will then be reinserted. This check verifies that the mobility of the control rod drive is not impaired.
3. During control blade movement the process computer or an alternate method will be utilized to time the travel of each control rod drive between notch positions to verify proper withdrawal and insertion times.

Results and Discussion

The single control rod subcriticality demonstration using the strongest worth control rod was successfully completed per DTS 8734 on May 28, 1997.(2) All control rod drive functional tests to demonstrate mobility and proper insertion and withdrawal times were completed successfully.

Startup Test No. 3 - TIP System Symmetry and Total Uncertainty

Purpose

This test performs a gross symmetry check and a detailed statistical uncertainty analysis on the Traversing Incore Probe (TIP) System.

Acceptance Criteria

For the gross check, the maximum deviation between symmetrically located TIP pairs of LPRM strings should be less than 25%. For the statistical check, the calculated X^2 of the integrated TIP responses should be less than 34.81.

NOTE: One data set may be used to meet the above criteria. If either criteria is not met, the instrumentation and data processing system should be checked for any problems that could lead to asymmetries. If the problem persists, the core management organization should be consulted to provide assurance that the larger than expected TIP asymmetries do not significantly affect core monitoring calculations.

Results and Discussion

One complete set of TIP data required for evaluating TIP uncertainty was obtained during the startup test program on July 8, 1997. The data was obtained at near full power steady state operating conditions. The results for each method of analysis are summarized below.

1. TIP Symmetry - Gross Check

In order to determine the overall symmetry of the TIP system, the machine-normalized, power adjusted 6-inch TIP readings were obtained and averaged over nodes 1 through 24 for each symmetric TIP pair (the symmetric locations are given in Table 3-1). The absolute percent deviation for each symmetric TIP pair was calculated and the results are summarized in Table 3-2. The maximum absolute deviation was 12.36%, which is within the acceptance criteria of 25%.

2. TIP Symmetry - Statistical Check

The TIP symmetry statistical analysis was performed using the standard X^2 test. The machine-normalized, power adjusted 6-inch TIP readings were obtained and used for the analysis. These TIP readings were summed over nodes 3 through 22 for each TIP tube location. The percent relative difference (Dm) for each symmetric TIP pair was then calculated using Equation 3-1 with the results summarized in Table 3-3. The TIP data variance (S^2TIP_{ij}) was calculated to be 13.48 using equation 3-2 and X^2 was calculated to be 6.74 using Equation 3-3. This value is within the acceptance criteria of 34.81.

Startup Test No. 3 - TIP System Symmetry and Total Uncertainty (continued)

Table 3-1 Symmetric TIP Locations

TIP Pair	LPRMs	TIP Pair	LPRMs
1	08-17 16-09	10	24-33 32-25
2	08-25 24-09	11	24-41 40-25
3	08-33 32-09	12	24-49 48-25
4	08-41 40-09	13	24-57 56-25
5	08-49 48-09	14	32-41 40-33
6	16-25 24-17	15	32-49 48-33
7	16-33 32-17	16	32-57 56-33
8	16-41 40-17	17	40-49 48-41
9	16-49 48-17	18	40-57 56-41

Startup Test No. 3 - TIP System Symmetry and Total Uncertainty (continued)

Table 3-2 TIP Symmetry - Gross Check

Symmetric TIP Pair	Absolute Percent Deviation
1	1.31
2	3.81
3	12.36
4	3.38
5	5.88
6	5.36
7	0.61
8	3.75
9	1.20
10	1.41
11	1.27
12	7.86
13	3.19
14	1.44
15	2.79
16	5.47
17	6.56
18	7.45

Maximum Absolute Percent Deviation: 12.36%

Table 3-3 TIP Symmetry - Statistical Check

Symmetric TIP Pair	Relative Difference, Dm
1	1.17
2	4.71
3	12.44
4	3.52
5	5.50
6	5.08
7	0.56
8	3.26
9	1.36
10	1.33
11	0.97
12	8.07
13	3.12
14	1.46
15	2.69
16	5.60
17	7.18
18	7.47

Equation 3-1

$$Dm = \frac{100(Tm_1 - Tm_2)}{\frac{(Tm_1 + Tm_2)}{2}}$$

Note: $Tm_1 = \sum_{k=3}^{22} T_1(k) for TIP_1 and Tm_2 = \sum_{k=3}^{22} T_2(k) for TIP_2$

where TIP_1 and TIP_2 are symmetric TIP pairs, and $T_1(k)$ and $T_2(k)$ are the machine normalized, power adjusted, 6-inch TIP readings for the respective TIP pair locations.

Equation 3-2

$$S^2 TIP_{ij} = \frac{\sum_{m=1}^{18} Dm^2}{36} = 13.48$$

Equation 3-3

$$X^2 = \frac{18(S^2 TIP_{ij})}{36} = 6.74$$

Startup Test No. 4 - Initial Criticality Comparison

Purpose

This test is used to perform a critical eigenvalue comparison. This is accomplished by comparing the predicted critical control rod pattern to the actual control rod pattern at the point of initial criticality and adjusting for reactor period.

Acceptance Criteria

The actual cold critical rod pattern must be within 1.0% $\Delta k/k$ of the predicted control rod pattern. If the difference is greater than 1.0% $\Delta k/k$, within 12 hours an analysis must be performed to determine and explain the cause of the reactivity difference.

Results and Discussion

Unit 3 was initially brought critical on June 16, 1997 at 1143 hours utilizing an A-2 sequence. The moderator temperature was 162 °F and the reactor period was 76 seconds. The critical prediction and rod worths were calculated by Nuclear Fuel Services using the MICROBURN code with an assumed moderator temperature of 170 °F.[3] After correcting for reactor period, the actual critical was found to be within 1.0% $\Delta k/k$ of the predicted critical. Table 4-1 summarizes the results.

Table 4-1 Initial Criticality Comparison Calculations

Critical Information	Value
predicted critical k_{eff}	1.00850 $\Delta k/k^{(3)}$
k_{eff} at time of criticality with 76 second period	1.01360 $\Delta k/k^{(4)}$
correction to ∞ period from 76 second period	0.000723994$\Delta k/k^{(3)}$
actual k_{eff} with ∞ period	1.01288 $\Delta k/k^{(5)}$
$\lvert$predicted k_{eff} - actual $k_{eff}\rvert$	0.00438 $\Delta k/k^{(5)}$
percent difference	0.438 $\%\Delta k/k^{(5)}$

Endnotes:

[1] Completed per DTS 8474, "Core Verification".
[2] Completed per DTS 8734, "Single Control Rod Subcriticality Demonstration".
[3] Documented in "D3C15 Zero Power Reactivity and Rod Worth Report," NDIT No. 970088.
[4] Completed per DTS 8273, "Reactor Criticals".
[5] Completed per DTS 8141, "Initial Criticality Comparison".