DRESDEN UNIT 2

CYCLE 11

STARTUP TEST REPORT

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STARTUP TESTING SUMMARY

Dresden Unit 2 resumed commercial operation for Cycle 11 on May 1, 1987, following a refueling and maintenance outage. During the outage, the third reload of Advanced Nuclear Fuels Corporation (formerly Exxon Nuclear Company) fuel was installed. The reload consisted of 172 9x9 fuel assemblies. This was the first reload of 9x9 fuel for Unit 2 and, as such, an operating license amendment was submitted for NRC review on December 10, 1986 (and supplemented on January 28 and February 5, 1987). The amendment was approved by letter from M. Grotenhuis to D. Farrar dated March 31, 1987.

The startup test program was similar to that performed for previous reloads at Dresden 2 and 3. The program consisted of various physics tests (shutdown margin, critical eigenvalue comparison, moderator temperature coefficient, etc.), and instrument calibrations (LPRM, TIP's, flow instrumentation) as addressed by the Technical Specifications, Final Safety Analysis Report, and previous commitments to the Nuclear Regulatory Commission. No unusual conditions were noted and the test results were as expected.

Summaries of the startup tests identified in the Draft Regulatory Guide SC 521-4 on refueling and startup tests for LWR reloads are attached per DPR-19 Technical Specification 6.6.A.1. Additional test results are available at the site.

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CYCLE 11

STARTUP TEST NO. 1

CORE VERIFICATION AND AUDIT

PURPOSE

The purpose of this test is to visually verify that the core is loaded as intended.

CRITERIA

The as-loaded core must conform to the reference core design used in the various licensing analyses. At least one independent party must either participate in performing the core verification or review a videotaped version prior to unit startup. Any discrepancies discovered in the loading will be promptly corrected and the affected areas reverified to ensure 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 11 core verification consisted of a core height check performed by the fuel handlers and two videotaped passes over the core by the nuclear group. The height check verifies the proper seating of an assembly in the fuel support piece while the video-tapes verify proper assembly orientation and location. On March 7, 1987, the core was verified as being properly loaded and consistent with the Advanced Nuclear Fuels Cycle 11 core reload design. Therefore, the as-loaded core configuration is consistent with that assumed in the evaluation of the Dresden Unit 2 Cycle 11 Reload Licensing Analyses.

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STARTUP TEST NO. 2

CONTROL ROD OPERABILITY AND SUBCRITICALITY CHECK

PURPOSE

The purpose of this test is to ensure that no gross local reactivity irregularities exist, that each control blade is latched to its control rod drive, and that all control blades are functioning properly.

CRITERIA

The following must be met:

1. Following the core reload, each control blade will be withdrawn and reinserted. This will guarantee that the mobility of the control blade is not impaired.

2. During control blade movement, the process computer or an alternate method is utilized to time the travel of the blade between notch positions in order to verify proper withdrawal and insertion times.

3. After the core is fully loaded, each control blade will be withdrawn and inserted individually to assure that criticality will not occur. As it is withdrawn, nuclear instrumentation will be monitored to verify subcriticality. Once withdrawn, each control blade is tested for overtravel by continually applying a withdrawal signal. A blade fails this check if rod position indication is not evident or if an overtravel alarm is received.

RESULTS AND DISCUSSION

All control rod drive functional tests were completed by April 16, 1987. After performing these tests, all control blades demonstrated acceptable mobility and proper withdrawal and insertion times. In addition, all blades passed their overtravel and subcriticality checks.

However, on May 3, 1987, control rod E-9 was discovered to be uncoupled during full core scram testing. In accordance with approved procedures, several attempts were made to re-couple E-9, but proved unsuccessful. Rod E-9 is currently at position 00 with the associated drive electrically disarmed in accordance with Technical Specification 3.3.B.1.b. The three symmetric rods have also been inserted to position 00 to maintain core symmetry.

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STARTUP TEST NO. 3

TIP SYSTEM SYMMETRY - UNCERTAINTY

PURPOSE

The purpose of this test is to perform a gross symmetry check and a detailed statistical uncertainty analysis on the Transversing In-Core Probe (TIP) System.

CRITERIA

1) TIP Symmetry - Gross Check

The maximum deviation between symmetrically located TIP pairs of LPRM strings should be less than 25%.

2) TIP Symmetry - Statistical Check

The calculated χ^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 fuel vendor should be consulted to assure that the larger than expected TIP asymmetries do not significantly affect core monitoring calculations.

RESULTS AND DISCUSSION

One complete set of data required for evaluating TIP uncertainty was obtained during the D2 BOC11 Startup Testing Program on May 29, 1987. Data were obtained at a steady state power level, 89% of rated. With the exception of rods 42-47 and 46-43, the control rod pattern maintained mirror symmetry across the axis that defines the line of symmetry for the TIP system. Rod 42-47 was at position 46 while rod 46-43 was full out at position 48. Since this difference in rod position impacts only the six inch unenriched uranium fuel length at the bottom of the surrounding fuel assemblies, the effects of this rod position asymmetry are negligible. 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, 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 is summarized in Table 3.2. The average absolute deviation for all symmetric TIP pairs was 4.54%, with a maximum absolute deviation of 11.75% which is well below the 25% criteria.

2) TIP Symmetry - Statistical Check.

The TIP symmetry statistical analysis was performed using the standard χ^2-test as recommended by Advanced Nuclear Fuels. The machine-normalized, 6-inch TIP readings obtained from a TIP set performed on May 29, 1987 were 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 (the results are summarized in Table 3.3). The TIP data variance (S^2TIP_{ij}) was calculated to be 18.04 using equation 3.2 and χ^2 was calculated to be 9.02 using equation 3.3. Note that the value for χ^2 is well within the limit of 34.81 established by Advanced Nuclear Fuels.

TABLE 3.1. Symmetric TIP Locations

TIP PAIR	LPRM	TIP PAIR	LPRM
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

TABLE 3.2. TIP Symmetry - Gross Check

Symmetric TIP Pair	Absolute Percent Deviation
1	7.30
2	2.84
3	4.19
4	7.98
5	1.10
6	1.09
7	2.98
8	5.97
9	4.94
10	1.65
11	1.03
12	11.21
13	11.75
14	3.27
15	2.38
16	1.15
17	1.79
18	9.14

Average Absolute Percent Deviation: 4.54

Maximum Absolute Percent Deviation: 11.75

TABLE 3.3. TIP Symmetry - Statistical Check

Symmetric TIP Pair	Relative Difference Dm
1	7.33
2	2.46
3	4.34
4	9.02
5	1.25
6	0.63
7	2.97
8	6.11
9	6.04
10	1.57
11	1.28
12	10.84
13	12.74
14	3.75
15	2.82
16	1.72
17	1.99
18	9.59

Equation 3.1

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

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, 6-inch TIP readings for the respective TIP pair locations.

Equation 3.2 (Variance)

$$S^2_{TIP_{ij}} = \frac{\sum_{m=1}^{18} Dm^2}{36} = 18.04$$

Equation 3.3

$$\chi^2 = \frac{18(S^2_{TIP_{ij}})}{36} = 9.02$$

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START-UP TEST NO. 4

INITIAL CRITICALITY COMPARISON

PURPOSE

The intent of this procedure is to perform a critical Eigenvalue comparison. This is done by comparing the predicted control rod pattern to the actual control rod pattern at criticality taking into account period and temperature coefficient corrections.

CRITERIA

The actual cold critical rod pattern shall be within 1.0% $\Delta K/K$ of the predicted control rod pattern. If the difference is greater than $\pm$ 1.0% $\Delta K/K$, Advanced Nuclear Fuels and Commonwealth Edison Company Core Management Engineers will be promptly notified to investigate the discrepancy.

RESULTS AND DISCUSSION

Unit 2 went critical on April 22, 1987 at 1:25 a.m. utilizing an A-2 sequence. The moderator temperature was 166°F and the period was 356 seconds. Advanced Nuclear Fuels predictions and rod worths were calculated using the XTGBWR Code, which assumed a moderator temperature of 170°F.

After corrections were made for temperature and period, the actual critical was within 0.002% $\Delta K/K$ of the predicted critical. This is well within 1.0% $\Delta K/K$ of the predicted critical. Table 4-1 summarizes the results.

TABLE 4-1

INITIAL CRITICALITY COMPARISON CALCULATIONS

ITEM	Δ k/k
k_{eff} with all rods in adjusted to 170°F	= 0.9448
ρ inserted by group 1 rods	= 0.0434 *
ρ inserted by group 2 rods	= 0.0116 *
ρ inserted by additional rods at criticality	= 0.00024*
Predicted k_{eff} at critical rod pattern (170°F)	= 1.00004*
Moderator temperature coefficient = -4.3×10^{-5}	(Δ k/k)/°F *
Temperature correction between 166°F and 170°F	= +0.00018
Predicted k_{eff} with temperature correction at critical rod pattern	= 1.00022
k_{eff} at time of criticality with ∞ period	= 1.000
Period correction for 356 second period	= +0.0002**
Actual k_{eff} with 356 second period	= 1.0002
(Predicted k_{eff} - actual k_{eff})	= 0.00002 Δ k/k
Percent Difference	= 0.002% Δ k/k

SOURCES

* Letter, R. A. Roehl to E. D. Eenigenburg, dated February 23, 1987

** ρ vs. τ tables

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July 14, 1987

Mr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Dresden Station Unit 2
"Dresden Unit 2 Cycle 11
Startup Test Report"
NRC Docket No. 50-237

Dear Mr. Murley:

In accordance with the requirements of Section 6 of the Dresden Station Tech Specs, attached please find a copy of the Dresden Unit 2 Cycle 11 Startup Test Report. Our Tech Specs require this document to be submitted to your staff within 90 days following resumption of commercial power operation. Transmittal of this document fulfills our Tech Spec requirements.

Please direct any questions you may have regarding this matter to this office.

Very truly yours,

I. M. Johnson
Nuclear Licensing Administrator

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Attachment

cc: M. Grotenhuis - NRR (w/Att.)
NRC Region III Administrator (w/Att.)
Region III Inspector - Dresden (w/Att.)

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