DRESDEN UNIT 3

CYCLE 10

STARTUP TESTING SUMMARY

Dresden Unit 3 resumed commercial operation for Cycle 10 on September 1, 1986, following a refueling and recirculation piping replacement outage. During the outage, the third reload of Exxon Nuclear Company (ENC) fuel was installed. The reload consisted of 176 9x9 fuel assemblies with natural uranium blankets on each end.

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.

As required by NRC SER for D3 Technical Specifications Amendment No. 87, an additional test to examine the in-core neutron instrumentation noise levels (peak-to-peak oscillations) during dual loop operation and single loop operation will be performed in conjunction with baseline data acquisition for the recirculation system. Due to unforseen delays during the initial startup of D3, this test will be performed and the results submitted to the NRC as soon as practicable.

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-25 Technical Specification 6.6.A.1. Additional test results are available at the site.

DRESDEN UNIT 3
CYCLE 10
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 be properly loaded 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 10 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 serial number/orientation visual check (which is videotaped) verifies proper assembly orientation and location. With members of the Audit Staff present, the core was officially verified as being properly loaded and consistent with Exxon Nuclear Cycle 10 core design on July 7, 1986. Therefore, the as-loaded core configuration is consistent with what Exxon Nuclear used in their evaluation of Dresden Unit 3 Cycle 10 Reload Licensing Analyses.

DRESDEN UNIT 3
CYCLE 10
STARTUP TEST NO. 2
CONTROL ROD OPERABILITY AND SUBCRITICALITY CHECK

PURPOSE

The intent 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:

a) Each control blade will be withdrawn after the four fuel assemblies in the given control cell are loaded. This will guarantee that the mobility of the control blade is not impaired.

b) During control blade movement, the process computer is utilized to time the travel of the blade between notch positions and verify proper withdrawal and insertion times.

c) 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 (SRM's) will be monitored to verify subcriticality. Once withdrawn, each control blade is tested for overtravel as required by Technical Specification 4.3.B. 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

Every control blade was withdrawn, checked for overtravel, and inserted to position 00 after fuel was loaded in that given cell. Therefore, each control blade's mobility was assured.

All control blades were timed during insertion and withdrawal and all but one were found to be acceptable. Control blade L-2 withdrew from position 0 to 48 approximately 1.6 seconds faster than the 38.4 seconds allowed procedurally and could not be slowed down to within normal withdraw time specifications. To allow operation of Unit 3 with this condition, L-2 must be notched out whenever it is withdrawn in accordance with Dresden Operating Order #29-86. This administrative control effectively limits the rate of rod withdrawal and, hence, reactivity insertion rate to well within the design basis.

After core loading, each control blade was withdrawn to position 48 to verify subcriticality. The SRM's were observed during the withdrawal and subcriticality was confirmed for every control blade. All control blades also passed their overtravel checks.

DRESDEN UNIT 3
CYCLE 10
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 Traversing 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

X^2 is a statistical tool that measures the consistancy between the actual (measured) TIP error distribution and that assumed in Exxon's error analysis. The calculated X^2 of the integrated TIP responses should be less than 34.81. X^2 is calculated using equation 3.3.

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

One complete set of data required for evaluating TIP uncertainty was obtained during the D3 BOC10 Startup Testing Program. Data was obtained at steady state power levels greater than 75% of rated power. 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, machine normalized, power adjusted six inch TIP readings were obtained and averaged for each symmetric TIP pair (the symmetric locations are given in Table 3.1). The absolute percent deviation between each symmetric TIP pair was calculated and summarized in Table 3.2. The maximum absolute deviation was 8.22% for TIP pair #4 which is well below the 25% criteria.

2) TIP Symmetry - Statistical Check.

The TIP symmetry analysis was performed using the standard X^2 test as recommended by Exxon Nuclear Company. Machine normalized, power adjusted six inch TIP values obtained from a whole core LPRM calibration performed during the startup test program were summed (elevations 3 through 22 only) for each TIP location. The absolute relative difference (Dm) for each symmetric TIP pair was then calculated using equation 3.1 - the results are summarized in Table 3.3. From equations 3.2 and 3.3 the variance and X^2 were calculated to be 8.06 and 4.03 respectively. Note that the value for X^2 is well within the limit established by Exxon of 34.81.

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	2.66
2	0.81
3	2.33
4	8.22
5	7.86
6	3.66
7	1.19
8	1.44
9	1.72
10	1.90
11	3.41
12	3.26
13	5.41
14	3.40
15	1.06
16	0.91
17	1.53
18	5.72

Maximum Absolute Percent Deviation: 8.22

TABLE 3.3. TIP Symmetry - Statistical Check

Symmetric TIP Pair	Relative Difference Dm
1	2.62
2	0.89
3	2.17
4	8.47
5	8.29
6	3.79
7	1.25
8	1.62
9	2.29
10	1.88
11	3.79
12	2.88
13	5.97
14	3.29
15	0.98
16	1.16
17	1.61
18	6.01

Equation 3.1 $$Dm = 100 \frac{(Tm_1 - Tm_2)}{\left(\frac{Tm_1 + Tm_2}{2}\right)}$$

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

for TIP_2 where TIP_1 and TIP_2 are symmetric TIP pairs.

Equation 3.2 (Variance)

$$S^2_{TIP_{ij}} = \sum_{m=1}^{18} \frac{Dm^2}{36} = 8.06$$

Equation 3.3

$$X^2 = \frac{18S^2_{TIP_{ij}}}{36} = 4.03$$

DRESDEN UNIT 3
CYCLE 10
STARTUP TEST NO. 4
INITIAL CRITICALITY COMPARISON

PURPOSE

The intent of this procedure is to perform a critical Eigenvalue comparison as required by Technical Specification 3.3.E. 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% Δk/k of the predicted control rod pattern. If the difference is greater than ± 1.0% Δk/k, Exxon Nuclear Company and Commonwealth Edison Company Core Management Engineers will be promptly notified to investigate the discrepancy.

RESULTS AND DISCUSSION

Unit 3 went critical on August 23, 1986 at 4:25 p.m. utilizing an A-2 sequence. The moderator temperature was 177°F and the period was 148.6 seconds. Exxon Nuclear 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 1.0% Δk/k of the predicted critical. Table 4-1 summarizes the results.

Note: Control rod J-6 (in Group 2 rods) was out-of-service when Unit 3 went critical. The PREDICT module of the POWERPLEX system was used to calculate the rod worth by comparing the core reactivity with J-6 inserted and fully withdrawn. The results in Table 4-1 assumed J-6 to be worth approximately 0.0006 Δk.

TABLE 4-1

INITIAL CRITICALITY COMPARISON CALCULATIONS

Predicted (XTGBWR Code) k_{eff}:

k_{eff} with all rods in adjusted to 170°F	= 0.943 *
Reactivity inserted by all group 1 rods	= 0.0336 *
Reactivity inserted by group 2 rods (except control rod J-6)**	= 0.0174 *
Reactivity inserted by additional rods from group 3 at criticality	= 0.00455 *
Predicted k_{eff} at critical rod pattern (170°F)	= 0.99855 *

Temperature correction to predicted k_{eff}:

Moderator temperature coefficient = -4.6×10^{-5} (Δ k/k)/°F *

Temperature correction between 177°F and 170°F	= -0.00032
Predicted k_{eff} at critical rod pattern (177°F)	= 0.99823

Period correction to actual k_{eff}:

k_{eff} at time of criticality with ∞ period	= 1.000
Period correction for 148.6 second period	= 0.0003976***
Actual k_{eff} with 148.6 second period	= 1.0003976

Difference

$\lvert$XTGBWR k_{eff} - actual $k_{eff}\rvert$ x 100%	= 0.217% Δk/k

SOURCES

* Exxon letter, J.M. Ross to R.A. Roehl, dated June 10, 1986.

** Exxon letter, J.M. Ross to R.A. Roehl, dated September 5, 1986.

*** ρ vs. τ tables