Dresden Unit 3

Cycle 8

Startup Testing Summary

Dresden Unit 3 resumed commercial operation for Cycle 8 on May 4, 1982 following a refueling and maintenance outage. During the outage the first reload of Exxon Nuclear Company fuel (for a jet pump BWR) was installed. The reload consisted of 224 fuel assemblies which are prepressurized, contain gadolinia burnable poison rods, and have a natural uranium blanket on each end. The fuel was designed to be hydraulically compatible with the current fuel types and to have similar thermal margin performance.

The startup test program performed 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.), instrument calibrations (LPRM, TIP's, flow instrumentation), and determination of baseline recirculation flow data as addressed by the Technical Specifications, Final Safety Analysis Report, and previous commitments to the Nuclear Regulatory Commission. No unusual conditions were noted, and test results were similar to previous cycles. This was expected due to the minimal changes in the fuel design.

In light of the new fuel vendor, summaries of the startup tests identified in the Draft Regulatory Guide 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.

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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 with the referenced core upon which the licensing analysis was performed. At least one independent person must either participate in performing the verification or review a videotape of the verification prior to a startup. Any discrepancies discovered in the loading will be promptly corrected and the affected areas reverified as to be properly loaded prior to startup.

Conformance to the reference loading will be documented by a permanent core serial map signed by the verifiers.

RESULTS AND DISCUSSION

The Cycle 8 core verification consisted of a core height check performed by the Fuel Handlers and two videotaped passes over the core by Nuclear Engineering personnel during which assembly orientations and locations were verified. During the first pass over the reactor core on April 9, 1982, two loading errors were identified. The errors were corrected immediately by removing the two assemblies from the reactor and inserting the correct fuel bundles instead. On April 10, 1982, the core was verified to be properly loaded and consistent with the Exxon Nuclear Cycle 8 core loading plan. Therefore, the as-loaded core conforms to the loading pattern used in the bases and assumptions of the Dresden Unit 3 Cycle 8 Reload License Analysis performed by Exxon Nuclear Company.

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Startup Test No. 2
Control Rod Operability and Subcritical Check

PURPOSE

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

CRITERIA

A. Each control rod will be withdrawn after the four fuel bundles surrounding the given control rod are loaded. This will insure that the mobility of the control rod is not impaired.

B. During the control rod movement, the process computer is used to time the travel of the rod between notches to verify proper withdrawal and insertion times.

C. After the core is fully loaded, each control rod will be withdrawn and inserted one at a time to assure that criticality will not occur due to the withdrawal of a single rod. Nuclear instrumentation will be monitored during the movement of each control rod to verify subcriticality. Once a control rod is fully withdrawn, it is tested for overtravel by trying to withdraw the rod further. A control rod fails the overtravel check if rod position indication is lost or if the overtravel alarm is received.

RESULTS AND DISCUSSION

Each control rod was withdrawn and inserted after the four fuel bundles surrounding the given control rod were loaded. Control rod mobility was assured.

All control rods were timed during insertion and withdrawal. All were found to be acceptable except for CRD B-9, which was found to have several notches with excessive times. Two of its directional control valves (121 and 123) were then replaced, which provided acceptable results.

After the core was loaded, each control rod was withdrawn and inserted one at a time. The Source Range Monitors were observed during the movement of each rod and subcriticality was verified. All of the control rods successfully completed the overtravel checks.

DRESDEN UNIT 3

STARTUP TEST NO.3

TIP SYSTEM SYMMETRY-UNCERTAINTY

PURPOSE

The primary purpose of this test is to determine the Transversing In-Core Probe (TIP) system uncertainty (using a detailed statistical analysis). A gross and statistical symmetry check, which involves comparing integrated symmetrical TIP string readings is performed.

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 variance of the integrated TIP responses shall 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 reviewed for any problems which could lead to asymmetries. If a new measured value of the variance is unsatisfactory, then the fuel vendor should be consulted to assure that larger than expected TIP asymmetries do not affect safe reactor operation.

RESULTS

One complete set of data required for evaluating TIP uncertainty was obtained during the D3 BOC 8 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)

To determine the symmetry component of TIP uncertainty, machine normalized, full power adjusted 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 symmetrical TIP pair was calculated and is given in Table 3.2. The average absolute deviation over all symmetric TIP pairs was 6.90%, with a maximum absolute deviation of 11.82%. The worst case pair is well below the 25% criterion on maximum deviation.

2) TIP Symmetry (Statistical Check)

The TIP symmetry (statistical) was calculated using the method recommended by Exxon Nuclear Company. From results of a whole core TIP run, OD-1, an average value for elevations 5 through 44 was calculated for each TIP location. The absolute relative difference for symmetric TIP pairs was found using Eq. 3.1 and the results are shown in Table 3.3. From these results, the standard deviation was calculated to be 34.10 with a resulting variance of 17.05 (see Eqs. 3.2 and 3.3). The variance of 17.05 is less than the 34.81 criterion.

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 56-24
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

TIP Pair	Absolute Percent Deviation
1	8.39
2	8.41
3	11.82
4	10.18
5	11.07
6	2.10
7	4.18
8	3.70
9	2.46
10	1.89
11	6.28
12	10.64
13	6.20
14	7.36
15	7.63
16	7.55
17	7.43
18	6.98

Average absolute percent deviation is 6.90.

TABLE 3.3. Absolute Relative Differences for Symmetric TIP Pairs

Symmetric TIP Pair	$\|dm\|$
1	9.08
2	9.50
3	12.95
4	10.42
5	12.38
6	2.21
7	5.43
8	4.11
9	2.11
10	2.08
11	5.93
12	11.21
13	5.80
14	8.77
15	8.14
16	9.41
17	8.92
18	7.71

Eq. 3.1. $$dm = \frac{100\ (Tm_1 - Tm_2)}{\frac{Tm_1 + Tm_2}{2}}$$

where $Tm_1 = \sum_{K=5}^{44} T(k)$ for TIP_1 and $TM_2 = \sum_{K=5}^{44} T(k)$ for TIP_2 of symmetric pairs.

Eq. 3.2. $$S^2 = \frac{\sum_{m=1}^{18} dm^2}{36} = 34.10$$

Eq. 3.3. $$\chi^2 = \frac{18S^2}{36} = 17.05$$

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Startup Test No. 4
Initial Criticality Comparison

PURPOSE

The purpose of this procedure is to perform a critical eigenvalue comparison. This is done by comparing the predicted critical control rod pattern to the actual critical control rod pattern and accounting for period and temperature coefficient corrections.

CRITERIA

The actual cold critical rod pattern should be within 1%ΔK of the predicted control rod pattern. If the difference is greater than $\pm$1% ΔK, Exxon Nuclear Company and Commonwealth Edison Company core management engineers will be promptly contacted to investigate the anomaly.

RESULTS AND DISCUSSION

The Unit 3 initial critical occurred on April 30, 1982, at 10:42 p.m. on the A sequence. The moderator temperature was 198^{o}F, and the period was 58.0 seconds. The Exxon Nuclear predictions and rod worths were performed using the XTGBWR code, which assumed a 170^{o}F moderator.

When corrected for temperature and period, the actual critical was within 1%ΔK of the predicted critical. Table 4-1 summarizes the results.

TABLE 4-1

CRITICAL EIGENVALUE CALCULATIONS

	K	Data Source
Keff with all rods in	0.9352	#2
ρ inserted by Group 1 rods	0.0390 ΔKeff	#1
ρ inserted by Group 2 rods	0.0150 ΔKeff	#1
ρ inserted by Group 4 rods* withdrawn at critical	0.0094 ΔKeff	#1
XTGBWR Keff at Critical Rod Pattern at 170°F	0.9986	
Temperature Correction between 170°F and 198°F	-.00112 ΔKeff	
MTC of $\frac{-4.0 \times 10^{-5}}{^{0}F} \frac{\Delta K}{K}$		#3
XTGBWR Keff at Critical Rod Pattern corrected for Temperature	0.9975	
Keff at time of Critical with ∞ period	1.000	
Period correction for 58 sec. period	+.00089 ΔKeff	#4
Actual Keff with 58 sec. period	1.00089	
Difference (XTGBWR Keff- Actual Keff)	.00339 ΔK .339% ΔK	

Data Sources Used in Calculations

#1. Enc. letter, J. L. Maryott to J. A. Silady, dated April 23, 1982.
#2. Enc. letter, J. W. Hulsman to D. G. Long, dated April 30, 1982.
#3. Actual Moderator Temp. Coeff. determined BOC-8 onsite.
#4. ρ vs. τ tables.

* The startup sequence was Groups 1, 2, 4, and 3 in that order.