July 23, 1992

Dr. Thomas E. Murley, Director Office of Nuclear Reactor Regulation U.S. Nuclear Regulatory Commission Washington, DC 20553

Attn: Document Control Desk

Subject:

Quad Cities Nuclear Station Unit 2

Startup Test Report Summary

NRC Docket No. 50-265

Dr. Murley:

Enclosed is the Quad Cities Nuclear Station Unit 2 Cycle 12 Startup Test Report. This report is submitted in accordance with the Quad Cities Technical Specifications and provided for your Staff's Information and use.

If there are any questions regarding this report, please contact me at (708) 515-7283.

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Nuclear Licensing Administrator

cc: A. Bert Davis, Regional Administrator-RIII

L.N. Olshan, Project Manager-NRR

T.E. Taylor, Senior Resident Inspector-Qued Cities

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QUAD-CITIES NUCLE IR POWER STATION

UNIT 2 CYCLE 12

STARTUP TEST RESULTS

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1. Shutdown Margin Demonstration and Control Rod Fur Conal Checks

Purpose

The purpose of this test is to demonstrate for this core loading in the most reactive condition during the operating cycle, that the reactor is subcritical with the strongest control rod full out and all other rods fully inserted.

Criteria

If a shutdown margin of 0.333% Δ K (=0.25% + R + B₄C settling penalty) cannot be demonstrated with the strongest control rod fully withdrawn, the core loading must be altered to achieve this margin. The core reactivity has been calculated to be at a maximum 4000 MWd/ST into the cycle and R is given as 0.033% Δ K. The control rod B₄C settling penalty for Unit Two is 0.05% Δ K.

Results and Discussion

On April 11, 1992, control rod H-9 was fully withdrawn to demonstrate that the reactor would remain subcritical with the strongest rod out. This rod was calculated by GE to have the highest worth with the core fully loaded at the beginning of the cycle. The strongest rod out maneuver was performed to allow single control rod withdrawals for CRD testing.

Control Rod functional subcritical checks were performed as part of control rod friction testing. No unexpected reactivity insertions were observed when any of the 177 control rods were withdrawn.

General Electric provided rod worth information for the two strongest diagonally adjacent rods G-10 and J-10 with rod H-9 fully withdrawn. This method provided an adequate reactivity insertion to demonstrate the desired shutdown margin. On April 11, 1992, a diagonally adjacent shutdown margin demonstration was successfully performed. Using the G.E. supplied rod worth for H-9 (the strongest rod) and diagonally adjacent rod G-10, it was determined that with H-9 at position 48, and G-10 at position 24, a moderator temperature of 137°F, and the reactor subcritical, a shutdown margin of 0.592% ΔK was demonstrated. The G.E. calculated shutdown margin with H-9 withdrawn and 68°F reactor water temperature was 3.001% ΔK at the beginning of Cycle 12.

At approximately 4000 MWd/ST into Cycle 12 a minimum calculated shutdown margin of 2.968% ΔF will occur with E-4 fully withdrawn.

G.E.'s ability to determine rod worth was demonstrated by the accuracy of their in-sequence criticality prediction. The ΔK difference between the expected critical rod pattern and the actual critical rod pattern was determined to be 0.2894% ΔK . This initial critical demonstrated that the actual shutdown margin at the beginning of cycle 11 was 3.2895% ΔK and 3.2574 ΔK at 4000 MWd/ST into cycle 12.

2. Core Verification

Purpose

The purpose of this test is to verify proper core location and orientation for each core fuel assembly.

Criteria

Prior to reactor startup, the actual core configuration shall be verified to be identical to the planned core configuration.

Results and Discussion

The Unit Two Cycle 12 core was verified on March 17, 1992. Fuel assembly orientation, seating, and ID serial number were verified for each assembly. Two inspection passes were made over each assembly. The first pass was made to verify orientation and seating of assemblies. The second pass was made to verify bundle ID numbers. A video camera was used during the inspection. All assemblies were found to be properly seated and orientated in their designated locations.

On March 21, 1992, 24 fuel assemblies were reverified due to the unload and reload of 4 fuel assemblies for control rod J-14 drive replacement. Two passes were again made for orientation, seating and ID verification. All 24 assemblies were found to be properly seated and orientated in their designated location. Similarly, on March 23, 1992, 22 fuel assemblies were reverified due to the unload and reload of eight fuel assemblies to allow drive replacement for control rods P-10 and P-11. Two passes were again made for orientation, seating and ID verification. All 22 fuel assemblies were found to be properly seated and orientated in the designated locations.

The bundle ID numbers are shown in Figure 1.

3. Initial Critical Prediction

Purpose

The purpose of this test is to demonstrate General Electric's ability to calculate control rod worths and shutdown margin by predicting the insequence critical.

Criteria

General Electric's prediction for the critical rod pattern must agree within 1% ΔK to actual rod pattern. A discrepancy greater than 1% ΔK will be cause for an On-Site Review and investigation by Nuclear Fuel Services.

Results and Discussion

On May 8, 1992, at 2041 hours the reactor was brought critical with reactor water temperature at the time of criticality of 165°F. The ΔK difference between the expected critical rod pattern at 68°F and the actual critical rod pattern at 165°F was 0.002894 from rod worth tables supplied by General Electric. The temperature effect was -0.00145 ΔK from General Electric supplied corrections. The excess reactivity yielding the 215 second positive period was 0.00029 ΔK . These reactivities resulted in a 0.001154 ΔK difference (0.1154% ΔK) between the expected critical rod pattern and the actual rod pattern. This is within the 1% ΔK required in the criteria of this test, and General Electric's ability to predict control rod worth is, therefore, successfully demonstrated.

4. Core Power Distribution Symmetry Analysis

Purpose

The purpose of this test was to determine the magnitude of indicated core power distribution asymmetries using data (TIP traces and OD-1) collected in conjunction with the CMC update.

Criteria

- A. The total TIP uncertainty (including random noise and geometric uncertainties obtained by averaging the uncertainties for all data sets) must be less than 9%.
- B. The gross check of TIP signal symmetry should yield a maximum deviation between symmetrically located pairs of less than 25%.

Results and Discussion

Core power symmetry calculations were performed based upon computer program OD-1 dat. runs on May 20 at 1303 and 2045 hours, both at 99.2.% and 98.9%, power respectively. The average total TIP uncertainty from the two TIP sets was 3.230%. The random noise uncertainty was 1.150%. This yields a geometrical uncertainty of 3.018%. The total TIP uncertainty was well within the 9% limit.

Table 1 lists the symmetrical TIP pairs and their respective average deviations. Figure 1 shows the core location of the TIP pairs and the average TIP readings. The maximum deviation between symmetrical TIP pairs was 8.51% for pair 5-33. Thus, the second criterion, mentioned above, was also met.

The method used to obtain the uncertainties consisted of calculating the average of the nodal ratio of TIP pairs by:

where Rij is the ratio for the ith node of TIP pair j, there being n such pairs, where n=18.

Next the standard deviation of the ratios is calculated by:

$$\sigma_{-} = \begin{bmatrix} n & 22 \\ \Sigma & \Sigma & (Rij - R)^{2} \\ j=1 & i=5 \\ \hline & (18n - 1) \end{bmatrix}$$
 1/2

 σ_R is multiplied by 100 to express σ_R as a percentage of the ideal value of σ_R of 1.0.

The total TIP uncertainty is calculated by dividing % o_R by $\sqrt{2}$ in order to account for data being taken at 3 inch intervals and analyzed on a 6 inch nodal basis.

In order to calculate random noise uncertainty the average reading at each node for nodes 5 through 22 is calculated by:

where NT = number of runs per machine = 5

MT = number of machines = 5

BASE (K) = average reading at nodal level K,

K = 5 through 22

The random noise is derived from the average of the nodal variances by:

% noise =
$$\begin{bmatrix} 22 & \text{MT} & \text{NT} \\ \Sigma & \Sigma & \Sigma \\ \text{K=5} & \text{M=1} & \text{N=1} \end{bmatrix} \begin{bmatrix} \text{BASE (N. M. K)} - \text{BASE (K)} \\ \text{BASE (K)} \end{bmatrix}^2 \times 100$$

Finally the (IP geometric uncertainty can be calculated by:

% o geometric = (%
$$\sigma$$
 total² - % σ noise²)1/2

Table 1

CORE SYMMETRY Based on OD-1's From 05-20-92 at 1303 Hours and 2045 Hours (99.2% and 98.9% Power Pespectively)

SYMMETRICAL TIP PAIR NUMBERS a-b 1-6 2-12 3-19 4-26 5-33 8-13 9-20 10-27 11-34 15-21 16-28 17-35 18-39 23-29 24-36 25-40 31-37	5.06 3.32 2.66 3.15 1.43 1.87 1.38 5.51 2.18 3.54 2.60 2.11 1.14 5.57 3.65	AVERAGE % DEVIATION DEVIATION T/((Ta + Tb)/2) 0.71 5.48 3.33 3.07 8.51 1.28 1.86 1.33 6.07 2.02 3.53 2.52 3.59 1.07 5.56 5.32 7.06
31-37 32-41	6.95 0.46 22 T ₁ = Σ T ₁ (K) /18	7.08 1.13 Average Deviation = 3.52
	1=5	

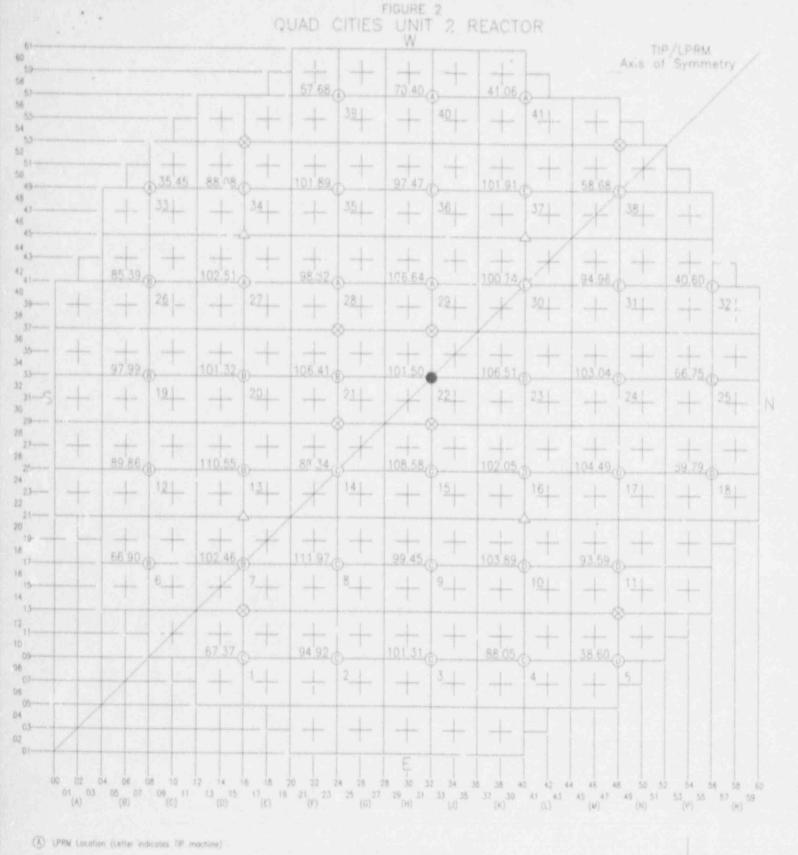
			YV							
[S		176 005 -716 665 -177 177 550 544	LYA LYA 647 653 LYF LYF 442 496	197 199	LYA LYA 584 591 LYF LYF 551 475	LYA S90				
\$\begin{array}{c c c c c c c c c c c c c c c c c c c	428 450 LYU LY	146 261 170 170 236 203	462 463	LYU J LYU	LYF LYF 497 503 LYG LYG 271 325	541 802 (M) (M	LYA L9A 657 597 LYF LYF 479 566	TOWN		
1717 529 486 425 302 213 29	0 LYO LYK 8 212 704 0 YJO YJO 2 214 295	YJO LYK 297 648 LYU VJO 229 215	LYK LYK	LYK 130 F97 300 9.60 1.60 216 225	178 LYU 668 220 740 740 296 217	YJO LYU 220 348 LYU YJO 291 218	LYU LW 324 4#7 LYU LY7 306 499		1/YA 692	
677 432 276 293 635 716 285 70	705 764 LYK LYK	Lau T vuo	17X 17X 773 732 17X 17X 679 671	V 85 1 1911	17K LYK 783 724 17K LYK 689 735	YJG LYU 294 272 YJG LYU 212 314	1,9K 1,7A 885 704 1,7K 1,7K 722 723	495 843 170 170	1YF LYA 571 554 1YF LYA 502 586	
LYA LYF LYU YJO LYU	296 788 LVU VJD	130 LYX 287 786 LYU V30 283 201	YJ0 YJ0 288 289 LYK (YX 672 711	V.85 1,40	1.YK YJ0 789 207 YJO 1.YU 285 305	LYK LYU 502 250 LYU LYK 244 673	(YU 1.V) 299 243 730 730 203 286	LYU VJO	1.YF 1.YA 554 608 1.YF 1.YF 492 555	1.YA 592
174 177 178 17U 17U	702 726 LYK LYK 700 664	Y3.5 (YU 281 328 LYK Y.40 776 277	644 696 17K LYK 657 674	7,60 LYK 278 743	667 792	LYU XJ0 346 197 YJ0 LYK 279 741	LYK LYK 737 666 LYK LYK 683 744	YJO (YU 198 240 YJO LYK 280 707	1901 197 345 475 190 197 190 100	
	7 270 775 270 775 1 170 730 340 265		YJG YJB 193 194 LYB LYU 231 241	1 VT LYU 522 252 LYU LYT 248 562	LYX YJ0 750 271 YJ0 LYU 266 347	190 Y30 300 272 Y30 LYK 190 733	170 730 259 273 730 C	LYU Y.80 260 274 Y.80 LYK 192 **20	170 (YF 253 465 (YU 170 242 251	197 1.6 569 68 197 1.7 567 64
	634 663	185 182 YJO LYU	AAR TOA	LYU YJO	17K LYK 677 688 LYK LYK 678 686	LYX Y.30 681 263 LYK Y.30 680 259	LYK LYK 645 746 LYK LYK 684 759	LYK YJ0 782 264 LYK YJ0 747 260	190 197 249 483 170 198 19 491	LYF LY 451 80 LYF LY 447 631
	331 256 Y/G CYK	190 563	191 236 191 236 7.0 730 175 176	LYU LYF 215 557 LYF LYU 572 268	YJO LYU 256 342 LYK YJO 784 251	YJO LYK 180 730 LYU YJO 333 252	YJO LYK 181 749 LYV YJO 210 253	LYUTYJO	LYU LYU 245 256 LYU LYF 211 474	TAL TA
LYA LIFF LYY LYU LYX YJO LYK LYK LYK YJO LYK LYK YJC 638 511 439 264 661 241 725 635 734 242 LYA LIFF LYF LYU LYYU YJO LYK LYK YJO LYK 593 434 422 295 189 171 719 793 172 296	760 660 LYK LYK	767 243 YJO LYU	LYK LYK 641 700 LYK LYK 642 694	244 736 LYU T YUO	LYK LYK 690 795 LYK LYK 754 712	YJO - LYK 245 731 LYU YJO 329 173	17K LYK 682 787 LYK LYK 739 738		LYU LYF 275 454 LYU LYF 336 487	
17A 17T LYF YJO LYU YJO YJO LYK LYG 677 512 444 165 518 235 166 853 188 LYA LYF LYU YJO LYU LYU LYU LYU 613 573 339 161 263 281 185 898	304 236 YaU LYK	319 167 YAO LYK	17K LYK 7t0 706 YJO YJO 232 253	LYK YJO.		UNU UNK 246 7 (3 UN LYU 691 237	YJN YJO 169 738 LYU LYO 334 767	LYU YJO 323 170 YJO LYU 164 337	LYF LYF 490 560 LYF LYA 552 636	EYA 600
UYA LYF LYU LYU LYK LYK LYU Y.0 675 437 298 279 640 703 320 153 LYA LYF LYF LYF LYA LYK LYU Y.0 612 558 457 427 709 717 192 227	768 718 LYK LYK	1YU YJO 213 158 7JO 17K 228 727	LYK LYK 695 715 LYK LYK 765 745	159 223		MAT ORL		LYU LYU 344 321 LYF LYF 509 467	LYF LYA 482 661 LYF LYA 564 598	
LYA LYT F LYT LYU YJO LYU 706 518 477 436 326 151 306 LYA LYF LYF LYF LYU LYU YJO 642 538 452 317 297 146	197 675	7JD LYK 221 643	YJO YJO 223	154 224 LYK 736 693 224	226 115 LYK LYU 701 228	307 156 YUO LYU 150 332	10 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m 1 m	LYF LYF 453 516 LYF LYA 530 654	LYA 68.3	
LYA LYF LYF LYF LYF LYF TS 155 423 527 458 LYA	170 LYU 282 717	170 170 221 207	Uni Unu 194 226	170 LYU 266 222	255 130	1YF LYF 468 534	LW LW 458 561			
LVA 617	LYF LYF 507 532 LYA LYA 627 624	LYF LYF 566 536 LYA LYA 726 649	LYF LYF 440 493 LYA LYA 581 659	57 570	LYF LYF 535 494 LYA LYA 625 634	LYA 664				
D0 02 04 06 08 10 12 14 16 18 01 01 03 05 07 09 (1 13 05 15 17 16 18	20 21 2	26 21	E 1	.34 .36	38 ·	42 44	45 A	8 50 51	54	6 58

SOURCE RANGE MONITORS

INTERMEDIATE RANCE MONITORS - RUS "A"

INTERMEDIATE RANGE MUNITORS - BUS "H"

DECAL POWER RANCE MONITORS



- LPRM Location (Common location for all TIP machines)
- (X) RM Locations
- A SRM Locations
- Source Lountions

UNIT TWO POWER SYMMETRY
AVERAGE BASE REALWASS
(NODES 5-22)
BASED ON OD-1's from
May 20, 1992 at 1303 Hours (99.2% Power)
May 20, 1992 at 7045 Hours (98.92% Power)

BASE AVERAGE

STRING NUMBER