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SUBJECT: "Startup Physics Testing Rept,Cycle 15."

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Startup Physics Testing Report, Cycle 15

The Monticello Cycle 15 Startup Physics Testing Report is attached. The startup physics testing consisted of three aspects; 1) shutdown margin test, 2) criticals, and 3) temperature coefficient. Cycle 15 is the first Monticello cycle to use the GE10 offset bundle design combined with the optimized fuel channel design. Section 6.7.A.1 of the Monticello Technical Specifications requires that a Startup Report be submitted within 90 days following resumption of commercial operation with fuel installed that has a different design or has been manufactured by a different fuel supplier.

Please contact us if you have any questions related to the attached Startup Report.

Thomas M Parker
Manager
Nuclear Support Services

c: Regional Administrator-III
NRR Project Manager, NRC
Senior Resident Inspector, NRC
J Silberg

Attachment

IE26
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ATTACHMENT

Startup Physics Testing Report, Cycle 15

Test 0073 - "Shutdown Margin Demonstration"

After withdrawing the control blade calculated to have the highest worth and additional reactivity to account for the Technical Specification required margin, inverted absorber tubes, calculational uncertainties, and temperature effects, the reactor was still subcritical. For Cycle 15, minimum shutdown margin occurs at Beginning of Cycle. Since adequate shutdown margin was demonstrated at this point, adequate shutdown margin exists throughout the cycle.

Test 8079 - "Beginning of Cycle Core Analysis Benchmark Critical"

Seven sets of critical data were gathered. These are two few-rod benchmark criticals, four B-sequence criticals, and an A-sequence critical. The B-sequence criticals are used in verifying symmetry of the core loading among the core quadrants. All of the criticals are used in benchmarking the Nuclear Analysis Department computer codes for future predictions and future core designs.

Figure 1 plots the cold critical values compiled by Nuclear Analysis Department since Cycle 7. These values are plotted as a function of cycle exposure and core average exposure. The plotted values do not include the historical bias. The mean of the cold critical values is 1.0024. The standard deviation is 0.0030. The cold critical value for the Cycle 15 was 1.0028. This is within 1 standard deviation of the mean of the distribution. In light of the significant fuel bundle design changes incorporated in the Cycle 15 reload, agreement between predictions and the actual core reactivity is good.

Two few-rod benchmark criticals were pulled because a different high worth control blade was predicted by core monitoring software (3D-Monicore) and the Nuclear Analysis Department methods. Both few-rod critical were within 0.20% Δk of the predicted values. These differences are within the 0.55% Δk reliability factor in the Nuclear Analysis Department critical predictions.

In the early steps of the B-sequence, control blade withdrawals are quadrant symmetric. Therefore, it is possible to establish a critical control blade configurations for all four quadrants. Figure 2 and 3 illustrate the symmetry predicted/actual control rod pattern at critical conditions. The predicted control blade configurations assume the quadrants are perfectly symmetric. Figure 4 shows a maximum difference in calculated reactivity of 0.05% Δk when quadrants 1 and 2 are compared. Cycles 8-14 were reviewed and the largest observed quadrant-to-quadrant difference in reactivity was approximately 0.27% Δk. Thus, the Cycle 15 observations fit extremely well within the Monticello experience base.

The A-sequence critical was pulled to startup the reactor (Monticello startup #190). The predicted and actual critical control blade configurations are shown in Figure 5. The difference in critical control blade configurations corresponds to 0.14% Δk. The reactor is 0.14% Δk less reactive than the cold model. This was within the 0.55% Δk reliability factor in the Nuclear Analysis Department critical predictions.

Test 8002 - "Temperature Coefficient Determination"

The data taken during the Cycle 15 startup was compared to the prediction based on Nuclear Analysis Department methods. The maximum difference in the temperature defect between the reactor and the Nuclear Analysis Department predictions is approximately 0.15% Δk. This value is reasonable.

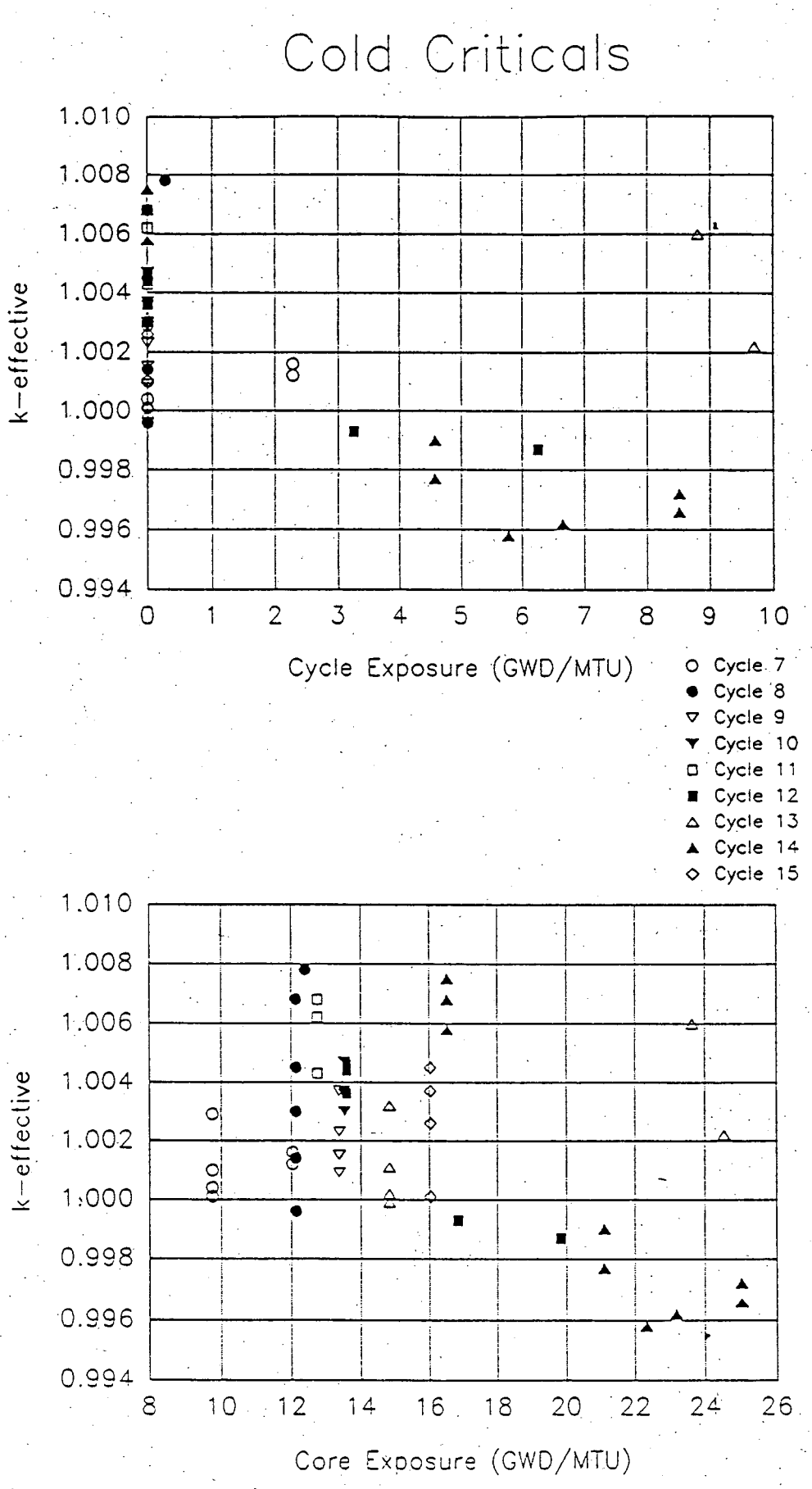

Cold Criticals
k-effective
1.010
1.008
1.006
1.004
1.002
1.000
0.998
0.996
0.994
0
1
2
3
4
5
6
7
8
9
10
Cycle Exposure (GWD/MTU)
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Cycle 11
Cycle 12
Cycle 13
Cycle 14
Cycle 15
k-effective
1.010
1.008
1.006
1.004
1.002
1.000
0.998
0.996
0.994
8
10
12
14
16
18
20
22
24
26
Core Exposure (GWD/MTU)

Figure 1

B Sequence Critical #1 - Predicted Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0	0	0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0	0	0		0		0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	0
27		0		0		0		0		0	0	0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0	0	0		0		0		0	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0	$\underline{24}$	0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

B Sequence Critical #2 - Predicted Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0	0	0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0		0		0		0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	0
27		0	**0**	0		0		0		0	$\underline{\mathbf{24}}$	0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0	**0**	0		0	**0**	0		0	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0		0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

B Sequence Critical #3 - Predicted Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0	$\underline{\mathbf{24}}$	0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0		0		0	$\underline{\mathbf{0}}$	0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{\mathbf{0}}$	0	0	0	0
27		0	**0**	0		0		0		0		0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0		0		0	$\underline{0}$	0		**0**	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0	$\underline{0}$	0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

B Sequence Critical #4 - Predicted Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0		0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0	$\underline{\mathbf{0}}$	0		0	**0**	0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	$\underline{0}$	0	**0**
27		0	$\underline{\mathbf{24}}$	0		0		0		0	$\underline{\mathbf{0}}$	0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0		0		0		0		0	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0	$\underline{\mathbf{0}}$	0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

Figure 2

B Sequence Critical #1 - Actual Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0	**0**	0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0	0	0		0		0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	0
27		0		0		0		0		0	**0**	0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0	**0**	0		0		0		**0**	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0	**24**	0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

B Sequence Critical #2 - Actual Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0	**0**	0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0		0		0		0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	0
27		0	**0**	0		0		0		0	**28**	0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0	**0**	0		0	**0**	0		0	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0		0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

B Sequence Critical #3 - Actual Rod Position

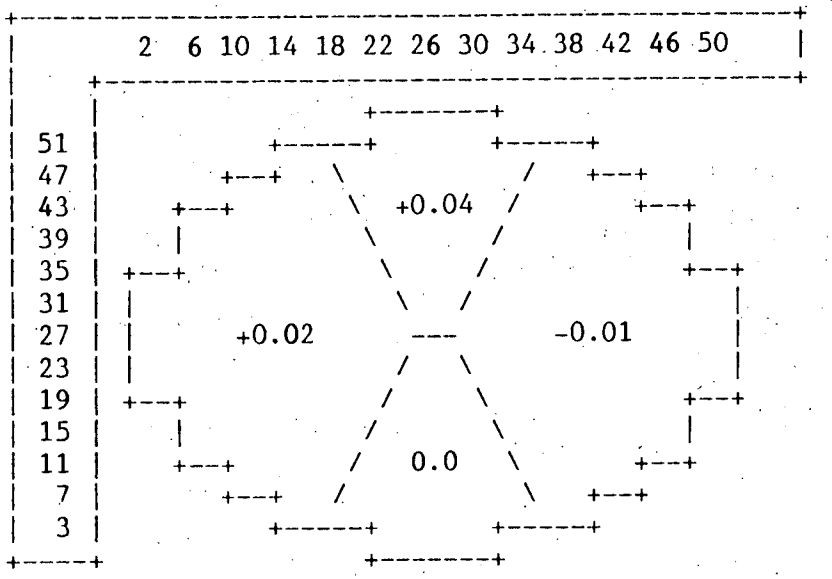
	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0	**16**	0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0		0		0	**0**	0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	0
27		0	**0**	0		0		0		0		0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0		0		0	**0**	0		0	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0	**0**	0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

B Sequence Critical #4 - Actual Rod Position

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0		0					
47				0	0	0	0	0	0	0			
43			0	0		0		0		0	0		
39		0	0	0	0	0	$\overline{0}$	0	0	0	0	0	
35		0		0	**0**	0		0	**0**	0		0	
31	0	0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	0
27		0	**20**	0		0		0		0	**0**	0	
23	0	0	$\overline{0}$	0	0	0	0	0	0	0	$\overline{0}$	0	0
19		0		0		0		0		0		0	
15		0	0	0	$\overline{0}$	0	0	0	$\overline{0}$	0	0	0	
11			0	0		0	**0**	0		0	0		
7				0	0	0	$\overline{0}$	0	0	0			
3						0		0					

Figure 3

B Sequence Critical Summary (Relative Reactivity % Delta-K)



These differences are small compared to previous cycles.

Figure 4

A Sequence - Predicted

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0	0	0					
47				0	0	0	0	0	0	0			
43			0	0	0		0		0	0	0		
39		0	0	0	0	0	0	0	0	0	0	0	
35		0	0		0	24	0		0		0	0	
31	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0		0		0		0		0	0	0		0
23	0	0	0	0	0	0	0	0	0	0	0	0	0
19		0	0		0	0	0		0		0	0	
15		0	0	0	0	0	0	0	0	0	0	0	
11			0	0	0		0		0	0	0		
7				0	0	0	0	0	0	0			
3						0	0	0					

A Sequence - Actual

	2	6	10	14	18	22	26	30	34	38	42	46	50
51						0	0	0					
47				0	0	0	0	0	0	0			
43			0	0	0		0		0	0	0		
39		0	0	0	0	0	0	0	0	0	0	0	
35		0	0		0		0		0		0	0	
31	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0		0		0		0		0	06	0		0
23	0	0	0	0	0	0	0	0	0	0	0	0	0
19		0	0		0	0	0		0		0	0	
15		0	0	0	0	0	0	0	0	0	0	0	
11			0	0	0		0		0	0	0		
7				0	0	0	0	0	0	0			
3						0	0	0					

Figure 5