NRC FORM 195
(2-76)

U.S. NUCLEAR REGULATORY COMMISSION

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DESCRIPTION

Ltr. re. our 12-18-75 Ltr....
Responses concerning resolution of Cycle 4 Startup Mearurement Data...W/Attached Tables & Figures......

(1 Original Received)

PLANT NAME: Monticello

ENCLOSURE

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ACKNOWLEDGED

FOR ACTION/INFORMATION

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HARLESS	PAWLICKI		HULMAN
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NRC FORM 195 (2-76)

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Carolina Power & Light Company

April 30, 1976

FILE: NG-3514 (R)

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Director of Nuclear Reactor Regulation
ATTN: Robert W. Reid, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Reid:

H. B. ROBINSON UNIT NO. 2
DOCKET NO. 50-263
LICENSE NO. DPR-23
RESOLUTION OF CYCLE 4 STARTUP MEASUREMENT DATA

Carolina Power & Light Company (CP&L) informed the Commission by letter dated December 18, 1975, that during the startup physics and power ascension testing for Cycle 4 the measured control rods worths and radial power distributions were significantly different from the predictions. A subsequent meeting with the Commission staff discussed these differences and the efforts to resolve them. The Company committed to provide the staff with results of reanalysis to assure that adequate shutdown margin was available throughout Cycle 4. The following information summarizes the results of the reanalysis.

The Cycle 4 Startup Test Report transmitted by letter dated March 15, 1976, to Mr. N. C. Moseley with a copy to Mr. W. G. McDonald provides a complete description of the startup test results and comparisons with the analytically predicted values. In general, the control rod worths were over predicted, and the predicted power distributions skewed toward the interior of the core with respect to the measured results. During the power escalation phase of the startup, the maximum measured F_{xy} exceeded the F_{xy} value of 1.435 employed in the calculations for the Constant Axial Offset Control (CAOC) limits. The Axial Power Distribution Monitoring System (APDMS) was reinstated to supplement the CAOC procedure for combinations of power levels and F_{xy} values which exceeded the CAOC limits of applicability. Our letter of December 18, 1975, provides further information on this matter.

The differences prompted an intensive effort on the part of the reload fuel supplier, Exxon Nuclear Company, Inc., in regard to the analytical results and on the part of CP&L in regard to reexamining the measurement techniques and reduction of the acquired raw data into meaningful experimental results. The objectives were to 1) determine the cause of the differences, 2) develop justifiable modifications to methods and/or application of methods where appropriate, 3) reevaluate results, and 4) reconfirm adequacy of Technical Specifications limits for the remainder of the cycle.

4383

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Comprehensive review of the experimental information acquired during the Physics Startup Test Program provides no insight into the cause for the differences. Further review of the conditioning of the raw data into results, however, revealed that the kinetic parameters used by the reactivity computer to interpret core kinetic response into absolute reactivity were not representative of the core. Detailed examination and reevaluation of the methodology resulted in including the effect of control rod insertion on the kinetic parameters which previously was ignored. The overall composite effect was in the direction to decrease the measured values by approximately 10% (see Table 1) which increases the size of the difference with respect to the original analyses.

The results of the review into the analyses identified two areas which required modification of techniques: 1) treatment of the steel baffle adjacent to the core with transport theory rather than diffusion theory, and 2) techniques of analytically representing control rods. The revised control rod calculational technique has been verified through comparisons with Monte Carlo analyses. The application of this modified technique gave a calculated N-1 rod worth that agreed within 5.1 percent of the measured value; however, a total resolution of the power distribution discrepancy could not fully be explained by current design tools. Consequently, an empirical adjustment to the neutronic properties of the baffle was formulated to produce agreement with the corresponding measurements. This empirical correlation is primarily justified on the basis of continued agreement with respect to the measurements for a variety of measured parameters subsequent to the initial startup measurements. The adjustment is considered a necessary interim step in order to reduce the uncertainty in predicting the end of Cycle 4 shutdown margin.

The excellent agreement of the revised power distribution calculations with respect to measurements is illustrated in Figure 1 for Map 209. For comparison, the original analysis of Map 209 taken from the Cycle 4 Startup Test Report is shown in Figure 2. Table 2 shows that the peripheral power (Region 7) in Map 209 is currently being calculated within 2.19%. The original analyses indicated an 8.54% standard deviation between prediction and measurement. The analyses of Maps 210 through 219, covering burnup to 3012 MWD/MTU, also show excellent agreement between measurement and prediction.

Reanalyses of the beginning and end of cycle control rod worth coupled with the reactivity requirements at these respective stated conditions provide assurance that satisfactory shutdown margin exists throughout the cycle even with the inclusion of 10% uncertainty on the calculations. The Cycle 4 shutdown margin confirmation is presented in Table 3 and shows an additional margin of 313 pcm for end of cycle conditions. The total shutdown requirements have been reevaluated down to 2855 pcm from the previous value of 3220 pcm on the basis of three-dimensional analyses with thermal-hydraulic and Doppler feedback. Using revised control rod worths, the allowance for D-bank insertion was calculated to be 250 pcm. A value of 300 pcm was adopted for conservatism. The redistribution effect was recalculated considering steady state and transient xenon distributions. With constant axial offset control limiting the xenon imbalance, the worst redistribution effect is 540 pcm. A value of 600 pcm was adopted for conservatism.

The safety analysis for the unit which was previously provided was examined for dependence upon control bank worth and power distribution and for continued applicability in light of the revised results presented above. The impact of the alterations in these input parameters is summarized as follows:

The PTS analysis (XN-75-14) made use of a scram bank worth of $4.66 which is conservative with respect to the reevaluated measured value $7.47 (4760 pcm). The results reported in XN-75-14, therefore, remain conservative.

The large break loss of coolant accident (LOCA), which is limiting at Robinson Unit 2, does not take credit for control rod insertion and is therefore unaffected by recent control rod worth changes. The LOCA analysis utilizes a peak rod $F_{\Delta H}$ of 1.55. The highest measured value to date has been less than 1.45 which is well within the assumed value. The large break LOCA analysis reported in XN-75-57, therefore, remains valid.

The small break analysis makes use of a scram bank worth which has changed somewhat between the time of the LOCA analysis and the present. The combined effect of updates in bank worths and kinetic parameters is to increase the integral of the reactor power during a scram by about 0.02 full-power seconds. The increase in peak cladding temperature resulting from this slight increase in energy deposition would be less than 20°F. As described in XN-75-57, the small break LOCA's are far from limiting for Robinson Unit 2, resulting in calculated peak clad temperature of about 1500°F.

The Company concludes that based on the reanalysis adequate shutdown margin is available throughout Cycle 4 and operation of H. B. Robinson Unit 2 with the control rod worths and power distributions existent in the core have an insignificant effect on the consequences considered in the original Cycle 4 safety analysis report.

Yours very truly,

E. E. Utley
Vice President
Bulk Power Supply

RLMjr/mfj
Attachments

cc: Mr. N. C. Moseley

Table 1

Measured and Corrected Control Bank Worths

Bank	Measured (PCM)*	Correction Factor	Revised Worth (PCM)
D	672	.901	606
C	1367	.913	1249
B	1342	.883	1185
A	884	.914	808
SD/B	509	.930	473
SD/A	1373	.940	1290

*From Cycle 4 Startup Test Report

H. B. ROBINSON UNIT 2 -- CYCLE 4

REGIONWISE POWER SHARING

MEASUREMENT vs. PREDICTION

MAP NO	MWD/MT	DATE	PWR %	D BANK	POWER FRACTION 4C	5	6	7	STANDARD DEVIATION* 4C	5	6	7
209°	567	10276	100	209	0.862	1.162	0.887	0.930	8.49	5.74	5.50	8.54
209+	567	10276	100	209	0.880	1.154	0.868	0.947	0.50	2.24	2.24	2.19
210+	1060	12376	100	212	0.872	1.152	0.866	0.945	0.91	5.25	5.83	6.81
211+	1278	13076	100	215	0.892	1.154	0.894	0.958	3.78	1.82	2.12	1.83
212+	1716	21376	100	215	0.886	1.149	0.892	0.954	3.30	2.20	2.70	2.76
213+	2151	22776	100	219	0.896	1.147	0.895	0.957	3.47	1.64	1.92	1.82
214+	2493	30976	100	219	0.909	1.147	0.896	0.953	4.24	1.90	2.58	2.69
215+	2525	31076	100	219	0.900	1.147	0.895	0.951	3.15	2.24	2.61	2.96
216+	2525	31076	100	219	0.905	1.147	0.897	0.958	3.73	1.83	1.87	2.56
217+	2588	31276	100	220	0.896	1.147	0.897	0.952	2.53	1.64	1.65	2.04
218+	2740	31776	100	190	0.883	1.141	0.895	0.962	0.72	1.56	1.32	1.57
219+	3012	32676	100	212	0.903	1.145	0.900	0.956	2.36	1.27	1.36	1.28

NOTE: * Standard Deviation of Percent Differences for Each Fuel Region

o Original Analysis

+ Revised Analysis

Table 3

End of Cycle 4
Shutdown Worth Requirements Table

Item		
Doppler Defect	1200	
Moderator Defect	705	
HFP D Bank Insertion	300	(420)*
Flux Redistribution	600	(850)*
Void	50	
Subtotal	2855	
Required Shutdown Margin to Cover the Steam Line Break	1830	@ 0 ppm
Total Required	4685	
Calculated Shutdown Worth of (N-1) Less 10%	4998	
Excess Margin	313	

* Original Values

FIGURE 1

REVISED ANALYSIS

H. B. ROBINSON UNIT 2 --- CYCLE 4

ASSEMBLY RELATIVE POWER - MAP 209

ASM'Y RELATIVE POWER EXPECTED /MEASURED/ % DIFF

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.730 0.716 -1.94	0.896 0.879 -1.94	0.730 0.725 -0.65						
2					0.716 0.762 6.55	0.980 0.981 0.12	1.210 1.195 -1.23	1.133 1.114 -1.69	1.210 1.202 -0.70	0.980 0.993 1.34	0.716 0.725 1.29				
3				0.812 0.858 5.68	1.217 1.244 2.22	0.916 0.909 -0.76	0.959 0.952 -0.73	0.871 0.848 -2.62	0.959 0.956 -0.32	0.916 0.952 3.99	1.217 1.251 2.78	0.812 0.822 1.22			
4			0.815 0.838 2.83	1.157 1.177 1.78	1.197 1.183 -1.23	1.197 1.182 -1.25	1.142 1.116 -2.26	1.135 1.086 -4.28	1.142 1.140 -0.17	1.197 1.277 6.63	1.197 1.230 2.70	1.157 1.153 -0.34	0.815 0.823 1.00		
5		0.724 0.727 0.42	1.228 1.233 0.42	1.202 1.195 -0.57	0.889 0.870 -2.10	0.842 0.828 -1.61	0.885 0.872 -1.45	1.136 1.115 -1.87	0.885 0.887 0.24	0.842 0.864 2.63	0.889 0.895 0.66	1.202 1.179 -1.90	1.228 1.239 0.89	0.724 0.751 3.68	
6		0.996 0.989 -0.66	0.936 0.930 -0.66	1.209 1.201 -0.66	0.845 0.882 4.34	0.874 0.870 -0.50	1.142 1.142 0.03	0.870 0.876 0.70	1.142 1.140 -0.19	0.874 0.863 -1.26	0.845 0.833 -1.50	1.209 1.190 -1.60	0.936 0.936 -0.09	0.996 1.010 1.42	
7	0.744 0.731 -1.65	1.234 1.209 -2.03	0.979 0.960 -1.90	1.157 1.153 -0.34	0.892 0.931 4.34	1.145 1.167 1.89	1.111 1.115 0.37	0.845 0.848 0.37	1.111 1.112 0.07	1.145 1.152 0.63	0.892 0.892 0.04	1.157 1.135 -1.89	0.979 0.952 -2.75	1.234 1.216 -1.46	0.744 0.736 -1.06
8	0.913 0.898 -1.65	1.160 1.135 -2.13	0.920 0.895 -2.69	1.154 1.152 -0.24	1.145 1.184 3.44	0.875 0.888 1.48	0.846 0.848 0.30	0.875 0.880 0.50	0.846 0.860 1.65	0.875 0.900 2.86	1.145 1.165 1.73	1.154 1.106 -4.21	0.920 0.870 -5.44	1.160 1.137 -1.95	0.913 0.904 -1.03
9	0.744 0.731 -1.65	1.234 1.204 -2.45	0.979 0.951 -2.85	1.157 1.146 -0.90	0.892 0.884 -0.86	1.145 1.153 0.71	1.111 1.121 0.89	0.845 0.855 1.25	1.111 1.130 1.73	1.145 1.169 2.12	0.892 0.903 1.23	1.157 1.109 -4.15	0.979 0.947 -3.29	1.234 1.210 -1.96	0.744 0.738 -0.82
10		0.996 0.967 -2.86	0.936 0.910 -2.86	1.209 1.180 -2.42	0.845 0.831 -1.76	0.874 0.873 -0.15	1.142 1.149 0.64	0.870 0.871 0.08	1.142 1.150 0.68	0.874 0.885 1.29	0.845 0.843 -0.27	1.209 1.182 -2.23	0.936 0.924 -1.30	0.996 0.991 -0.41	
11		0.724 0.718 -0.93	1.228 1.216 -0.93	1.202 1.191 -0.93	0.889 0.873 -1.76	0.842 0.830 -1.37	0.885 0.872 -1.46	1.136 1.118 -1.60	0.885 0.880 -0.56	0.842 0.846 0.48	0.889 0.893 0.52	1.202 1.208 0.49	1.228 1.231 0.27	0.724 0.724 -0.09	
12			0.815 0.823 1.00	1.157 1.168 1.00	1.197 1.154 -3.63	1.197 1.154 -3.63	1.142 1.101 -3.56	1.135 1.097 -3.35	1.142 1.115 -2.37	1.197 1.179 -1.53	1.197 1.204 0.58	1.157 1.190 2.88	0.815 0.821 0.78		
13				0.812 0.816 0.48	1.217 1.216 -0.05	0.916 0.899 -1.84	0.959 0.919 -4.20	0.871 0.832 -4.44	0.959 0.926 -3.53	0.916 0.884 -3.42	1.217 1.207 -0.85	0.812 0.829 2.15			
14					0.716 0.715 -0.05	0.980 1.000 2.01	1.210 1.225 1.27	1.133 1.118 -1.39	1.210 1.178 -2.61	0.980 0.951 -2.91	0.716 0.690 -3.55				
15							0.730 0.768 5.19	0.896 0.917 2.26	0.730 0.714 -2.27						

567 MWD/MT 100% POWER D @ 209 STEPS

ORIGINAL ANALYSIS

H. B. ROBINSON UNIT 2 -- CYCLE 4

ASSEMBLY RELATIVE POWER - MAP 209

ASM'Y RELATIVE POWER EXPECTED /MEASURED/ % DIFF

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.613	0.765	0.613						
							0.701	0.873	0.694						
							14.24	14.25	13.15						
2					0.623	0.885	1.123	1.066	1.123	0.885	0.623				
					0.729	0.889	1.160	1.112	1.215	0.987	0.693				
					17.11	0.35	3.31	4.32	8.19	11.46	11.38				
3				0.737	1.164	0.897	0.953	0.871	0.953	0.897	1.164	0.737			
				0.847	1.242	0.886	0.945	0.841	0.956	0.959	1.266	0.819			
				14.90	6.67	-1.23	-0.90	-3.45	0.30	6.96	8.76	11.13			
4			0.740	1.129	1.213	1.239	1.194	1.177	1.194	1.239	1.213	1.129	0.740		
			0.807	1.197	1.194	1.169	1.131	1.085	1.158	1.269	1.252	1.173	0.805		
			9.02	5.98	-1.59	-4.02	-5.29	-7.80	-3.00	2.40	3.23	3.82	8.78		
5		0.631	1.174	1.218	0.926	0.897	0.957	1.234	0.957	0.897	0.926	1.218	1.174	0.631	
		0.656	1.220	1.230	0.892	0.835	0.870	1.122	0.895	0.861	0.891	1.176	1.263	0.749	
		3.92	3.92	0.96	-3.65	-6.88	-9.06	-9.06	-6.41	-4.00	-3.74	-3.49	7.64	18.77	
6		0.900	0.917	1.250	0.901	0.958	1.267	0.965	1.267	0.958	0.901	1.250	0.917	0.900	
		0.912	0.930	1.268	0.866	0.862	1.143	0.872	1.135	0.857	0.837	1.194	0.953	1.011	
		1.34	1.37	1.41	-3.82	-9.93	-9.78	-9.67	-10.42	-10.55	-7.10	-4.55	3.93	12.35	
7	0.624	1.144	0.970	1.207	0.963	1.270	1.246	0.944	1.246	1.270	0.963	1.207	0.970	1.144	0.624
	0.716	1.177	0.955	1.177	0.924	1.166	1.111	0.843	1.110	1.147	0.891	1.135	0.961	1.197	0.658
	14.73	2.88	-1.53	-2.52	-4.06	-8.20	-10.85	-10.75	-10.89	-9.68	-7.53	-5.98	-0.96	4.63	5.42
8	0.778	1.088	0.914	1.193	1.242	0.971	0.945	0.973	0.945	0.971	1.242	1.193	0.914	1.088	0.778
	0.892	1.135	0.891	1.139	1.180	0.897	0.840	0.862	0.855	0.894	1.151	1.113	0.874	1.137	0.855
	14.74	4.30	-2.51	-4.52	-5.01	-7.56	-11.13	-11.37	-9.52	-7.92	-7.35	-6.69	-4.36	4.55	10.00
9	0.624	1.144	0.970	1.207	0.963	1.270	1.246	0.944	1.246	1.270	0.963	1.207	0.970	1.144	0.624
	0.716	1.186	0.951	1.147	0.880	1.169	1.124	0.850	1.127	1.160	0.891	1.130	0.966	1.232	0.724
	14.73	3.65	-1.93	-4.99	-8.68	-7.99	-9.77	-9.98	-9.56	-8.64	-7.51	-6.41	-0.44	7.67	15.97
10		0.900	0.917	1.250	0.901	0.958	1.267	0.965	1.267	0.958	0.901	1.250	0.917	0.900	
		0.888	0.905	1.195	0.817	0.866	1.144	0.871	1.156	0.881	0.840	1.175	0.934	0.993	
		-1.32	-1.30	-4.41	-9.30	-9.54	-9.70	-9.77	-8.75	-7.99	-6.79	-6.04	1.81	10.45	
11		0.631	1.174	1.218	0.926	0.897	0.957	1.234	0.957	0.897	0.926	1.218	1.174	0.631	
		0.661	1.230	1.277	0.841	0.818	0.869	1.114	0.881	0.842	0.899	1.245	1.237	0.693	
		4.79	4.79	4.82	-9.17	-8.84	-9.19	-9.68	-7.94	-6.18	-2.85	2.25	5.41	9.81	
12			0.740	1.129	1.213	1.239	1.194	1.177	1.194	1.239	1.213	1.129	0.740		
			0.821	1.253	1.116	1.139	1.097	1.081	1.124	1.188	1.213	1.197	0.810		
			10.89	10.91	-7.95	-8.05	-8.11	-8.18	-5.83	-4.09	0.02	6.02	9.45		
13				0.737	1.164	0.897	0.953	0.871	0.953	0.897	1.164	0.737			
				0.831	1.333	0.927	0.889	0.829	0.943	0.884	1.174	0.790			
				12.66	14.50	3.32	-6.73	-4.78	-1.01	-1.41	0.84	7.21			
14					0.623	0.885	1.123	1.066	1.123	0.885	0.623				
					0.713	1.050	1.270	1.127	1.154	0.895	0.610				
					14.58	18.64	13.06	5.72	2.77	1.06	-2.05				
15							0.613	0.765	0.613						
							0.766	0.893	0.639						
							24.91	16.76	4.17						

567 MWD/MT

100% POWER

D @ 209 STEPS