ATTACHMENT A

ANSWERS TO QUESTIONS CONCERNING:

LOOSE PARTS MONITORING PROGRAM
AND
CYCLE 2 STARTUP PHYSICS TESTS

Indian Point Unit No. 2

Docket No. 50-247

March 9, 1977

8111230432 770309
PDR ADOCK 05000247
P PDR

1. Q. What is the average rate of occurrence of impacting for 1-,2-,3-, and 4-pump operation?

A. The average rate of occurence of impacts based on operating pumps is as follows:

With one pump operating the average rate of impacts was 1.4 impacts per second during a sampling time of 28 seconds.

With two pumps operating the average rate of impacts was 0.7 impacts per second during a sampling time of 27 seconds.

With three pumps operating the average rate of impacts was 0.4 impacts per second during a sampling time of 45 seconds.

With 4 pumps operating no impacts were noted at any time.

2. Q. Can you rule out flow-induced vibration and impacting of core internals. i.e., core barrel impacting of keyways, loose thermal shield, etc.? Present evidence available to us would support such an hypothesis.

A. Analysis of the data recorded from four accelerometers mounted on the bottom of the Indian Point #2 vessel, using triangulation techniques, located the source in the bottom of the vessel. Thus flow induced core barrel impacting on the vessel edge can be ruled out. The source of impacts was also found to be moving in a random manner indicating that it was a moving object.

3. Q. Have you measured core barrel motion at various power levels using excore neutron noise? If so, what scale factor was used and how much motion was indicated both before and after refueling? What is the nominal clearance between core barrel and keyway at the bottom of the vessel?

A. Neutron noise from the excore power range detectors was recorded during cycle 1 at various power levels and during cycle II at 70% and 100% of full power to evaluate gross core barrel signature characteristics. This technique is not a direct method to measure the isolated core barrel motion regardless of the scale factor used. This is because the neutron noise signature contains indications of many types of motion existing in the reactor coolant system (core barrel, thermal shield, pump vibration, etc). All the neutron noise measurements showed no unusual patterns in the amplitude or signature from cycle 1 to cycle 2.

The nominal as assembled clearance between the core barrel and keyway is 6 mils.

4. Q. Have you attempted to time correlate large excursions of excore neutron detector signals with the accelerometer signals indicating impacting? If so, what was the result?

A. No abnormal or large excursions of excore neutron detector signals were measured in cycle I or cycle II neutron noise data recordings. Therefore, no attemps have been made to correlate neutron noise with accelerometers located on the bottom of the vessel, since no impact signals were detected during normal power operation with four pumps running.

5. Q. What is the reproducibility of the impact signal? For example, after operating with four pumps and no impacting, when the flow is reduced to 1-,2-,3- pump operations is the location and amplitude of impacting the same?

A. The amplitude of the impact signals are generally reproducible with pump startups. Location of the impacting indication moved as described in the answer to question 2.

No data is available, for the sequence when the flow is reduced to 3-,2-,1- pump operation after a four pump operation condition.

6. Q. How does background noise change when 2, 3, 4 pumps are operated? Could the background noise mask the impacting signal at 4-pump operation?

A. The background noise levels change with different pump configurations in the following manner:

With one pump operating the background noise level is the highest. This is probably due to the turbulence of reactor coolant.

Using one pump noise as a base, the effects of multiple pump operation are expressed as factors of the base background noise.

(1) Two-pump operation - the background noise reduced to 0.8 of the base.

(2) Three pump operation further reduces the background to 0.7 of the base.

(3) Four pump operation reduces the background noise level to 0.7 of the base.

Observed data indicates that for the impacts to be masked by background noise during 4 pump operation, the impacts would have to be very small.

7. Q. What is the approximate impacting signal-to-background noise ratio?

A. The average impact signal to noise ratio for 1,2, and 3 pump operation is:

1 pump	2.5 to 1
2 pumps	4.5 to 1
3 pumps	3.8 to 1

8. Q. Could the filtering that is applied to the raw accelerometer signals change the audible sound of loose part impacting? Is filtering done on audible signal? What is the pass band?

A. The accelerometer output is fed to a remote charge pre-amplifier that has a ± 2% frequency response from 0.2HZ to 50KHZ. The output of the charge pre-amplifier is fed to a signal conditioner amplifier whose frequency response is ± 2% from 10HZ to 20KHZ. Signals for all tape recordings were taken from the output of the signal conditioners.

This conditioned signal is inputted to an audio amplifier whose total harmonic distortion is less than 0.5% from 100HZ to 20KHZ. A filter is provided for the audio amplifier. This filter has a nominal band pass of 2KHZ, over a range of 1 to 20 KHZ. A switch is provided to use the filter or to by-pass it in the audio amplifier circuit. If the filter were used, it could, depending upon the filter setting and the predominant frequency of the impact, change the audible sound of loose part impacting. However, this filter was not used while audibly monitoring the impacts, and thus had no effect upon the audible signal.

9. Q. Explain further the last statement of paragraph 4 in your response to question 1 on November 29. "The fact that at full temperature, impacts were noted during pump transients and none during normal full flow operation indicated that the source was not wedged anywhere and it remained stationary under normal operations."

A. As explained in the answer to question 1 the indications of impacting were noted only when three or fewer pumps were operating. During these operating conditions, movement of the impact source was also detected. When four pumps were operating, no impacting was detected. The inpacting would start again when the system was next operated with one or more pumps removed from service. These results indicated that the normal flow patterns with all reactor coolant pumps operating was sufficient to maintain the "loose part" stationary. Apparently, however, the source was not wedged in place, because impacting indications resumed when the system was later operated with less than full four pump flow.

10. Q. Provide axial power distributions for Map 1 through 8. These axial distributions should include traces from locations B-3, D-3, and B-13, plus at least two traces from Regions 2,3, and 4. The same locations should be chosen for each of the eight maps.

A. Axial power distributions for Map 1 through 8 are provided in Figures 1 through 8 respectively. They include nine core locations, namely: R-8 and N-2 from Region 4, L-13 and K-6 from Region 2, G-9 and F-7 from Region 3 and the specifically requested core locations D-3, B-13 and B-3. The distributions are in KW/FT and are normalized to 100% rated power (2758 MW_t).

Axial Power Distribution (KW/FT)

Figure 1

Map 1: HZP (normalized to 2758 MW_t)

Core Locations

Axial Position	R8	N9	L13	K6	G9	F7	D3	B13	B3
1 (Top of Core)	1.243	1.529	1.972	3.720	3.244	4.521	1.323	1.437	1.539
2	1.602	1.740	3.593	4.350	5.238	5.318	2.437	1.544	1.714
3	2.087	2.650	3.946	4.911	4.436	4.744	3.856	2.034	2.198
4	2.991	3.452	5.353	5.390	5.948	5.390	5.270	2.915	3.022
5	3.843	4.079	6.735	7.525	7.432	7.850	5.510	3.702	3.830
6	4.575	4.219	7.736	7.759	8.326	8.707	7.324	4.372	4.550
7	4.711	5.125	7.556	8.135	7.949	8.348	7.402	4.445	4.602
8	5.902	5.633	9.138	8.833	9.291	9.752	8.316	5.597	5.635
9	6.559	5.952	9.708	8.902	9.561	9.970	9.320	5.019	5.233
10	6.931	6.345	10.025	8.844	9.598	9.973	9.549	5.500	5.610
11	7.238	6.520	10.192	8.658	9.420	9.833	9.343	5.350	6.020
12	7.475	6.589	10.135	8.412	9.157	9.590	9.921	5.995	7.057
13	7.550	6.589	10.109	8.133	8.847	9.257	9.901	7.039	7.106
14	7.452	5.997	9.357	7.301	8.420	8.791	9.549	6.952	7.005
15	6.649	6.450	8.596	7.238	7.131	7.583	8.913	6.252	6.301
16	7.533	6.450	9.558	7.270	7.771	8.162	9.708	7.039	7.074
17	7.617	6.554	9.500	7.059	7.602	7.922	9.553	7.127	7.143
18	7.559	6.554	9.358	6.754	7.349	7.675	9.553	7.127	7.108
19	7.462	6.450	9.151	6.492	7.056	7.382	9.378	7.112	7.057
20	7.277	6.206	8.943	6.255	6.731	7.003	9.165	6.394	6.885
21	7.051	5.992	8.561	5.857	6.421	6.729	8.394	6.346	6.679
22	6.315	5.509	7.340	5.056	5.703	5.886	7.770	5.388	5.924
23	5.532	5.737	7.909	5.435	5.735	6.068	8.332	5.165	6.147
24	6.557	5.683	8.027	5.283	5.723	6.053	8.332	5.107	6.216
25	6.470	5.543	7.307	5.079	5.548	5.835	8.157	5.048	6.113
26	6.293	5.359	7.530	4.859	5.315	5.678	7.944	5.917	5.958
27	5.939	5.055	7.389	4.639	5.099	5.346	7.654	5.726	5.735
28	5.754	4.463	6.952	4.079	4.756	5.037	7.053	5.436	5.391
29	5.114	4.916	6.128	4.235	4.215	4.531	6.527	4.839	4.911
30	5.475	4.776	6.552	4.204	4.463	4.751	5.840	5.174	5.151
31	5.330	4.567	6.487	4.051	4.353	4.569	5.685	5.057	5.014
32	5.201	4.463	6.280	3.881	4.191	4.473	5.491	4.397	4.893
33	5.015	4.238	6.053	3.755	4.045	4.280	5.259	4.578	4.705
34	4.735	3.835	5.772	3.512	3.822	4.056	5.958	4.533	4.533
35	4.140	3.800	4.371	3.101	3.250	3.457	5.077	3.393	3.846
36	4.417	3.835	5.256	3.276	3.487	3.724	5.484	4.133	4.199
37	4.345	3.765	5.158	3.147	3.440	3.611	5.329	4.110	4.138
38	4.214	3.526	4.968	3.063	3.353	3.584	5.133	3.831	4.001
39	4.033	3.452	4.300	2.935	3.226	3.399	4.999	3.739	3.812
40	3.873	3.312	4.605	2.934	3.087	3.272	4.786	3.629	3.657
41	3.671	2.998	4.403	2.649	2.941	3.125	4.553	3.454	3.434
42	3.128	2.929	3.755	2.370	2.541	2.712	3.356	2.959	2.936
43	3.317	2.998	3.958	2.528	2.731	2.936	4.047	3.133	3.125
44	3.212	2.719	3.902	2.467	2.686	2.685	4.011	3.075	3.056
45	3.109	2.580	3.766	2.460	2.589	2.851	3.337	2.929	2.936
46	2.945	2.510	3.592	2.408	2.594	2.781	3.643	2.796	2.799
47	2.755	2.301	3.445	2.289	2.526	2.723	3.438	2.594	2.575
48	2.531	2.057	3.245	2.187	2.449	2.569	3.255	2.413	2.387
49	2.071	1.813	2.783	1.998	2.154	2.263	2.732	1.953	1.923
50	2.044	1.743	2.790	2.093	2.256	2.391	2.329	1.924	1.923
51	1.858	1.569	2.551	1.930	2.196	2.321	2.516	1.778	1.759
52	1.602	1.325	2.418	1.786	2.053	2.190	2.325	1.530	1.528
53	1.327	.941	2.039	1.584	1.807	1.947	1.976	1.195	1.271
54	1.041	.767	1.738	1.270	1.552	1.641	1.569	.933	1.030
55	.633	.593	1.270	.845	1.152	1.223	1.134	.593	.635
56	.753	.334	.355	.750	.862	.849	.775	.729	.704
57 (Bottom of Core)	.294	.139	.930	.519	.926	.787	.426	.277	.292

Axial Power Distribution (KW/FT)

Figure 2

Map 2: 35% of full power

(normalized to 2758 MW_t)

Core Locations

Axial Position	R8	N2	L13	K6	G9	F7	D3	B13	B3
1	.915	1.125	1.250	1.983	2.214	3.345	.701	.908	.911
2	.909	1.225	2.060	2.336	3.316	3.669	1.608	1.136	1.384
3	1.280	1.771	2.141	2.885	2.724	2.984	2.515	1.268	1.679
4	1.740	2.227	2.841	3.778	3.631	3.985	3.422	1.836	2.203
5	2.220	2.650	3.585	4.569	4.453	4.919	4.184	2.309	2.660
6	2.560	2.739	4.114	4.973	4.960	5.543	4.679	2.725	2.874
7	2.783	3.341	4.096	5.016	4.768	5.315	4.782	2.782	3.300
8	3.435	3.730	4.888	5.620	5.604	6.247	5.668	3.444	3.806
9	3.821	4.031	5.250	5.782	5.810	6.497	6.019	3.823	4.126
10	4.174	4.265	5.507	5.858	5.906	6.577	6.307	4.126	4.388
11	4.468	4.454	5.690	5.865	5.916	6.589	6.513	4.353	4.612
12	4.705	4.586	5.995	5.769	5.971	6.543	6.692	4.570	4.777
13	4.915	4.651	6.276	5.634	6.032	6.487	6.850	4.693	4.884
14	4.934	4.259	6.295	5.418	5.879	6.334	6.788	4.731	4.592
15	4.985	4.807	5.640	5.093	5.264	5.585	6.560	4.351	4.931
16	5.604	5.020	6.479	5.517	5.899	6.242	7.264	4.997	5.244
17	5.831	5.143	6.661	5.562	5.927	6.262	7.409	5.206	5.400
18	6.010	5.232	6.756	5.540	5.941	6.242	7.533	5.339	5.507
19	6.135	5.277	6.793	5.499	5.902	6.209	7.595	5.434	5.556
20	6.199	5.266	6.854	5.431	5.847	6.148	7.636	5.453	5.537
21	6.149	5.075	6.874	5.330	5.756	6.070	7.595	5.415	5.352
22	5.632	4.964	6.455	4.798	5.232	5.585	6.788	5.111	4.989
23	6.218	5.321	6.632	5.158	5.555	5.814	7.578	5.225	5.516
24	6.417	5.411	7.006	5.267	5.709	6.029	7.864	5.491	5.614
25	6.488	5.467	7.079	5.270	5.688	6.035	7.947	5.548	5.672
26	6.509	5.500	7.103	5.244	5.665	6.004	7.967	5.605	5.672
27	6.502	5.411	7.102	5.206	5.623	5.980	7.905	5.605	5.585
28	6.157	4.807	6.942	4.930	5.433	5.804	7.450	5.510	5.088
29	6.135	5.400	6.236	4.809	5.037	5.270	7.409	4.940	5.487
30	6.515	5.478	7.045	5.178	5.520	5.834	7.864	5.548	5.604
31	6.569	5.511	7.140	5.189	5.549	5.855	7.926	5.624	5.623
32	6.574	5.523	7.150	5.158	5.512	5.832	7.947	5.624	5.623
33	6.556	5.456	7.112	5.109	5.468	5.777	7.947	5.567	5.584
34	6.402	5.087	7.010	4.997	5.367	5.699	7.802	5.529	5.302
35	5.853	5.210	6.311	4.517	4.718	5.069	6.891	5.016	5.154
36	6.416	5.422	6.790	4.909	5.258	5.570	7.719	5.396	5.545
37	6.513	5.422	6.951	4.994	5.342	5.671	7.740	5.548	5.565
38	6.492	5.388	6.925	4.971	5.379	5.681	7.740	5.548	5.526
39	6.442	5.344	6.900	4.968	5.335	5.638	7.698	5.510	5.457
40	6.355	5.232	6.832	4.945	5.309	5.609	7.616	5.434	5.350
41	6.140	4.885	6.747	4.848	5.218	5.556	7.471	5.301	5.020
42	5.563	4.897	6.100	4.391	4.599	4.971	6.560	4.731	4.803
43	6.047	5.075	6.456	4.774	5.152	5.452	7.284	5.092	5.136
44	6.029	5.020	6.574	4.888	5.265	5.597	7.222	5.149	5.097
45	5.903	4.897	6.503	4.902	5.265	5.622	7.119	5.092	4.990
46	5.724	4.718	6.415	4.917	5.265	5.609	6.953	4.940	4.795
47	5.453	4.483	6.273	4.914	5.276	5.585	6.788	4.769	4.542
48	5.087	4.013	6.100	4.827	5.232	5.523	6.498	4.465	4.094
49	4.318	3.700	5.416	4.365	4.664	4.995	5.587	3.800	3.673
50	4.378	3.600	5.504	4.638	5.059	5.282	5.919	3.800	3.616
51	3.986	3.231	5.348	4.595	4.984	5.251	5.587	3.572	3.275
52	3.484	2.784	4.942	4.345	4.725	4.991	5.070	3.173	2.836
53	2.889	2.269	4.392	3.931	4.273	4.539	4.387	2.736	2.320
54	2.162	1.621	3.678	3.328	3.658	3.903	3.497	2.166	1.638
55	1.493	1.297	2.783	2.450	2.743	2.998	2.401	1.387	1.286
56	1.626	.906	1.850	1.840	2.016	2.085	1.925	1.577	1.034
57	.948	.168	2.035	1.403	2.300	2.110	.911	.760	.195

Top of Core

Bottom of Core

Axial Power Distribution (KW/FT)

Figure 3

Map 3: 70% of full power
(normalized to 2758 MW_t)

Core Locations

Axial Position	R8	N2	L13	K6	G9	F7	D3	B13	B3
Top of Core 1	.851	1.424	1.084	3.215	5.020	4.401	1.021	1.495	1.205
2	1.112	1.493	2.037	3.362	4.062	3.806	2.082	1.329	1.682
3	1.790	2.076	2.989	4.186	3.934	4.347	3.142	1.901	2.159
4	2.509	2.647	4.035	5.126	5.141	5.520	4.208	2.496	2.640
5	3.131	3.082	5.051	5.755	6.155	6.375	5.083	3.027	3.123
6	3.661	3.220	5.616	5.691	6.417	6.499	5.707	3.379	3.222
7	3.964	3.822	5.855	6.373	6.702	7.098	5.678	3.648	3.917
8	4.778	4.253	6.613	6.705	7.444	7.612	6.800	4.268	4.341
9	5.259	4.545	6.978	6.776	7.614	7.724	7.160	4.611	4.621
10	5.614	4.769	7.214	6.767	7.633	7.705	7.395	4.870	4.855
11	5.866	4.924	7.342	6.686	7.545	7.641	7.560	5.064	5.009
12	6.031	4.993	7.379	6.580	7.409	7.520	7.687	5.166	5.099
13	6.114	4.993	7.361	6.396	7.212	7.315	7.736	5.212	5.090
14	5.999	4.545	7.120	5.601	6.618	6.571	7.580	5.009	4.540
15	5.720	4.958	6.626	6.023	6.453	6.745	7.014	4.972	5.135
16	6.280	5.131	7.210	6.068	6.761	6.862	7.795	5.370	5.298
17	6.398	5.199	7.226	5.983	6.674	6.745	7.843	5.472	5.361
18	6.446	5.217	7.193	5.858	6.583	6.620	7.853	5.518	5.388
19	6.457	5.199	7.148	5.740	6.435	6.494	7.814	5.499	5.352
20	6.388	5.113	7.085	5.596	6.273	6.334	7.765	5.444	5.262
21	6.254	4.907	6.948	5.261	5.965	5.990	7.648	5.286	4.946
22	5.687	4.631	6.224	4.923	5.508	5.539	6.761	4.685	4.901
23	6.088	4.993	6.757	5.272	5.873	6.012	7.473	5.222	5.162
24	6.251	5.027	6.901	5.218	5.873	5.990	7.609	5.277	5.198
25	6.260	5.044	6.893	5.173	5.789	5.921	7.638	5.268	5.189
26	6.238	5.027	6.835	5.091	5.713	5.846	7.590	5.259	5.153
27	6.162	4.924	6.748	4.978	5.560	5.697	7.473	5.185	5.018
28	5.787	4.339	6.329	4.368	5.140	5.089	7.102	4.768	4.459
29	5.647	4.821	6.141	4.873	5.201	5.444	6.809	4.925	4.946
30	6.010	4.872	6.604	4.911	5.423	5.530	7.239	5.083	4.973
31	6.051	4.872	6.605	4.857	5.375	5.491	7.258	5.083	4.964
32	6.027	4.855	6.580	4.804	5.309	5.416	7.239	5.055	4.946
33	5.974	4.803	6.494	4.718	5.232	5.324	7.219	4.990	4.873
34	5.823	4.545	6.294	4.357	4.916	4.993	7.073	4.870	4.476
35	5.357	4.476	5.662	4.368	4.679	4.849	6.195	4.416	4.693
36	5.761	4.683	6.216	4.566	5.042	5.192	6.897	4.879	4.846
37	5.832	4.683	6.263	4.558	5.056	5.175	6.946	4.907	4.846
38	5.812	4.666	6.221	4.540	5.034	5.147	6.936	4.870	4.792
39	5.762	4.614	6.163	4.494	4.985	5.089	6.887	4.814	4.711
40	5.676	4.528	6.088	4.424	4.935	5.053	6.829	4.722	4.612
41	5.505	4.270	5.930	4.158	4.685	4.779	6.673	4.564	4.197
42	4.965	4.115	5.314	4.135	4.462	4.634	5.834	4.074	4.323
43	5.331	4.356	5.814	4.372	4.834	5.000	6.468	4.527	4.456
44	5.358	4.339	5.844	4.392	4.873	5.042	6.429	4.527	4.413
45	5.259	4.218	5.778	4.405	4.870	5.039	6.331	4.444	4.305
46	5.104	4.098	5.697	4.409	4.860	5.018	6.214	4.314	4.142
47	4.893	3.891	5.567	4.359	4.851	4.974	6.078	4.111	3.906
48	4.590	3.547	5.345	4.125	4.638	4.707	5.843	3.814	3.429
49	3.923	3.220	4.680	4.006	4.412	4.524	5.014	3.240	3.285
50	3.945	3.151	4.923	4.168	4.656	4.745	5.336	3.342	3.123
51	3.652	2.858	4.718	4.000	4.516	4.588	5.044	3.074	2.807
52	3.244	2.514	4.335	3.697	4.209	4.250	4.614	2.703	2.437
53	2.716	2.066	3.828	3.226	3.757	3.761	4.019	2.278	1.967
54	2.094	1.515	3.145	2.583	3.092	3.038	3.307	1.704	1.309
55	1.376	1.136	2.246	1.713	2.202	2.117	2.302	1.130	1.291
56	1.607	.947	1.711	1.738	1.993	2.080	1.775	1.361	.758
57	.587	.189	1.462	.979	2.284	1.619	.985	.306	.135

Axial Power Distribution (KW/FT)

Figure 4

Map 4: 70% of full power

(normalized to 2758 MW_t)

Core Locations

Axial Position	R8	N2	L13	K6	G9	F7	D3	B13	B3
1 (Top of Core)	.701	.950	1.959	1.318	1.892	2.580	.740	.776	.489
2	.788	1.022	1.923	1.990	3.010	2.792	1.449	.971	.828
3	.991	1.470	1.887	2.662	2.309	2.867	2.159	1.082	1.166
4	1.396	1.864	2.424	3.451	2.978	3.645	2.869	1.534	1.504
5	1.769	2.222	3.088	4.002	3.718	4.321	3.509	1.913	1.842
6	2.131	2.312	3.559	4.197	4.200	4.535	3.948	2.237	2.180
7	2.228	2.814	3.545	4.439	4.058	4.868	4.008	2.292	2.243
8	2.842	3.136	4.220	4.896	4.763	5.351	4.818	2.847	2.768
9	3.211	3.405	4.555	5.033	5.019	5.556	5.148	3.152	3.079
10	3.534	3.602	4.804	5.115	5.143	5.655	5.378	3.420	3.346
11	3.848	3.782	5.000	5.175	5.209	5.695	5.598	3.642	3.560
12	4.089	3.931	5.292	5.104	5.311	5.696	5.806	3.824	3.744
13	4.277	4.010	5.555	5.008	5.407	5.648	5.975	3.960	3.875
14	4.433	3.686	5.641	4.661	5.362	5.271	5.985	4.016	3.946
15	4.154	4.172	5.083	4.774	4.778	5.308	5.734	3.682	3.607
16	4.892	4.388	5.857	5.067	5.438	5.657	6.476	4.285	4.188
17	5.161	4.549	6.076	5.133	5.534	5.709	6.656	4.526	4.402
18	5.360	4.657	6.207	5.143	5.591	5.746	6.807	4.684	4.554
19	5.511	4.747	6.319	5.148	5.619	5.734	6.927	4.795	4.679
20	5.612	4.783	6.410	5.135	5.610	5.747	7.017	4.851	4.741
21	5.663	4.675	6.485	5.029	5.595	5.618	7.047	4.869	4.759
22	5.336	4.477	6.196	4.635	5.225	5.460	6.376	4.619	4.554
23	5.685	4.945	6.311	5.105	5.392	5.662	7.198	4.767	4.598
24	6.008	5.071	6.778	5.194	5.674	5.892	7.488	5.073	4.973
25	6.157	5.179	6.903	5.240	5.722	5.951	7.629	5.175	5.089
26	6.242	5.233	6.990	5.257	5.744	5.973	7.719	5.249	5.188
27	6.299	5.215	7.035	5.243	5.761	5.927	7.739	5.305	5.223
28	6.217	4.675	6.963	4.867	5.659	5.532	7.458	5.277	5.179
29	5.766	5.269	6.234	5.124	5.132	5.619	7.318	4.776	4.679
30	6.436	5.430	7.176	5.395	5.792	6.006	7.879	5.416	5.268
31	6.570	5.520	7.335	5.428	5.881	6.082	8.010	5.518	5.375
32	6.647	5.556	7.403	5.429	5.894	6.090	8.120	5.593	5.438
33	6.687	5.538	7.435	5.421	5.886	6.082	8.190	5.611	5.473
34	6.653	5.323	7.399	5.217	5.853	5.826	8.130	5.602	5.473
35	6.031	5.359	6.748	4.928	5.234	5.699	7.188	5.129	5.054
36	6.655	5.664	7.242	5.386	5.752	6.041	8.100	5.555	5.420
37	6.826	5.718	7.509	5.462	5.941	6.164	8.240	5.741	5.625
38	6.898	5.718	7.539	5.485	5.981	6.195	8.320	5.787	5.679
39	6.897	5.682	7.563	5.509	5.995	6.199	8.340	5.787	5.670
40	6.857	5.628	7.539	5.485	5.991	6.195	8.320	5.750	5.625
41	6.748	5.359	7.475	5.284	5.955	5.960	8.200	5.567	5.536
42	6.321	5.251	6.834	4.988	5.350	5.848	7.238	5.175	5.045
43	6.566	5.556	7.215	5.471	5.867	6.187	8.080	5.481	5.321
44	6.675	5.538	7.435	5.569	6.058	6.358	8.090	5.648	5.491
45	6.596	5.448	7.420	5.609	6.093	6.389	7.990	5.611	5.464
46	6.453	5.287	7.356	5.637	6.122	6.397	7.909	5.500	5.348
47	6.229	5.035	7.246	5.622	6.150	6.366	7.749	5.314	5.143
48	5.917	4.567	7.058	5.441	6.124	6.180	7.488	5.045	4.875
49	5.255	4.244	6.317	5.092	5.513	5.885	6.426	4.424	4.295
50	5.097	4.100	6.429	5.424	5.941	6.127	6.867	4.331	4.152
51	4.736	3.704	6.322	5.257	5.915	5.998	6.486	4.118	3.946
52	4.246	3.219	5.873	4.931	5.624	5.620	5.925	3.682	3.563
53	3.607	2.625	5.253	4.375	5.130	5.007	5.173	3.209	3.071
54	2.806	1.870	4.465	3.594	4.430	4.175	4.190	2.588	2.446
55	1.805	1.564	3.425	2.530	3.422	2.984	2.877	1.697	1.616
56	2.307	1.097	2.285	2.289	2.397	2.412	2.356	1.836	1.696
57 (Bottom of Core)	1.975	.216	1.895	2.458	2.872	1.635	1.283	.965	.938

Axial Power Distribution (KW/FT)

Figure 5

Map 5: 70% of full power

(normalized to 2758 MW_t)

Core Locations

Axial Position (Top of Core – Bottom of Core)

	R8	N2	L13	K6	G9	F7	D3	B13	B3
1	1.582	1.532	2.474	3.526	5.713	5.942	1.461	1.561	1.632
2	1.434	1.619	2.524	3.808	4.557	4.750	2.554	1.718	1.542
3	1.962	2.281	3.421	4.469	4.334	4.627	3.648	2.370	2.164
4	2.700	2.947	4.529	5.557	5.586	5.868	4.748	3.018	2.809
5	3.395	3.424	5.576	6.259	6.730	6.929	5.744	3.529	3.330
6	3.962	3.546	5.933	6.314	7.092	7.254	5.258	3.576	3.556
7	4.111	4.227	6.350	6.925	7.416	7.618	6.472	4.359	4.108
8	5.134	4.716	7.185	7.369	8.238	8.428	7.471	4.820	4.597
9	5.627	5.013	7.568	7.449	8.425	8.630	7.840	5.142	4.941
10	6.046	5.258	7.782	7.436	8.450	8.637	8.092	5.372	5.194
11	6.325	5.380	7.890	7.346	8.358	8.548	8.238	5.529	5.366
12	6.511	5.485	7.931	7.227	8.192	8.422	8.335	5.603	5.465
13	6.595	5.467	7.873	7.022	7.959	8.191	8.354	5.557	5.465
14	6.474	4.908	7.354	6.255	7.290	7.495	8.034	4.976	5.058
15	6.046	5.398	7.132	6.515	7.024	7.223	7.811	5.584	5.375
16	6.734	5.537	7.642	6.564	7.385	7.562	8.364	5.750	5.610
17	6.835	5.555	7.648	6.454	7.265	7.436	8.393	5.806	5.664
18	6.846	5.572	7.572	6.286	7.106	7.251	8.345	5.815	5.692
19	6.836	5.502	7.479	6.127	6.940	7.085	8.257	5.732	5.646
20	6.734	5.398	7.375	5.945	6.721	6.882	8.160	5.512	5.538
21	6.576	5.153	7.093	5.610	6.375	6.532	7.947	5.207	5.303
22	5.767	4.821	6.711	5.113	5.909	6.150	6.957	5.161	4.850
23	6.334	5.168	6.885	5.490	6.135	6.280	7.772	5.363	5.266
24	6.436	5.188	7.030	5.402	6.133	6.317	7.821	5.345	5.293
25	6.409	5.170	6.963	5.316	6.020	6.218	7.782	5.299	5.257
26	6.325	5.101	6.850	5.196	5.891	6.105	7.665	5.225	5.194
27	6.232	4.978	6.700	5.058	5.711	5.907	7.471	5.059	5.049
28	5.897	4.332	6.212	4.478	5.221	5.429	5.870	4.469	4.416
29	5.627	4.769	6.056	4.829	5.193	5.322	5.399	4.958	4.814
30	5.953	4.804	6.445	4.862	5.423	5.578	7.122	4.949	4.841
31	5.916	4.769	6.406	4.787	5.345	5.508	7.073	4.893	4.805
32	5.876	4.699	6.317	4.691	5.232	5.399	7.006	4.810	4.760
33	5.795	4.612	6.196	4.580	5.124	5.276	6.918	4.709	4.669
34	5.618	4.332	5.845	4.257	4.797	4.943	6.705	4.248	4.407
35	4.948	4.262	5.564	4.094	4.543	4.758	5.899	4.497	4.298
36	5.497	4.437	5.800	4.340	4.825	4.979	6.501	4.552	4.524
37	5.497	4.402	5.824	4.307	4.823	4.980	6.472	4.515	4.497
38	5.441	4.332	5.752	4.264	4.764	4.900	6.423	4.451	4.425
39	5.357	4.262	5.672	4.204	4.684	4.829	6.326	4.368	4.343
40	5.237	4.192	5.563	4.131	4.614	4.749	6.229	4.248	4.226
41	5.060	3.878	5.269	3.866	4.347	4.481	5.045	3.906	3.972
42	4.399	3.808	5.043	3.706	4.173	4.366	5.288	3.981	3.800
43	4.855	3.948	5.201	3.994	4.437	4.596	5.851	4.064	4.009
44	4.827	3.913	5.233	4.011	4.466	4.631	5.754	3.999	3.963
45	4.725	3.825	5.165	4.002	4.447	4.627	5.547	3.889	3.864
46	4.548	3.668	5.056	3.985	4.419	4.594	5.521	3.732	3.710
47	4.344	3.476	4.922	3.953	4.388	4.527	5.375	3.511	3.511
48	4.065	3.162	4.624	3.735	4.200	4.320	5.123	3.050	3.185
49	3.358	2.847	4.336	3.556	4.015	4.174	4.425	2.986	2.877
50	3.451	2.795	4.308	3.748	4.182	4.251	4.587	2.820	2.805
51	3.153	2.533	4.108	3.609	4.066	4.165	4.415	2.543	2.543
52	2.800	2.218	3.755	3.333	3.792	3.903	4.027	2.184	2.226
53	2.335	1.834	3.263	2.939	3.394	3.512	3.464	1.769	1.801
54	1.786	1.345	2.652	2.379	2.783	2.885	2.785	1.207	1.294
55	1.135	1.031	1.909	1.595	2.044	2.149	1.911	1.235	1.032
56	1.488	.838	1.510	1.587	1.767	1.814	1.611	.582	.751
57	.446	.175	1.806	.890	2.067	1.870	.728	.129	.471

Axial Power Distribution (KW/FT)

Figure 6

Map 6: 70% of full power

(normalized to 2758 MW_t)

Core Locations

Axial Position (Top of Core → Bottom of Core)	R8	N8	L13	K6	G9	F7	D3	B13	B3
1	.933	1.268	2.448	2.313	4.973	4.757	1.119	1.094	1.142
2	1.226	1.357	2.508	2.671	4.095	3.753	2.069	1.235	1.160
3	1.620	1.929	2.567	3.308	3.218	3.915	3.020	1.450	1.475
4	2.255	2.433	3.444	4.247	4.235	4.909	3.976	2.043	2.000
5	2.814	2.867	4.391	4.978	5.309	5.747	4.786	2.543	2.499
6	3.299	2.957	5.017	5.342	5.970	6.003	5.232	2.938	2.878
7	3.590	3.548	4.950	5.402	5.750	6.432	5.493	2.985	2.914
8	4.285	3.943	5.889	5.046	6.711	7.027	5.305	3.570	3.636
9	4.700	4.229	6.281	6.194	6.984	7.219	6.603	4.036	3.970
10	5.039	4.427	6.526	6.244	7.066	7.241	6.843	4.289	4.223
11	5.286	4.552	6.663	6.221	7.026	7.197	6.980	4.496	4.421
12	5.452	4.642	6.724	6.158	6.926	7.099	7.089	4.636	4.565
13	5.545	4.642	6.737	6.043	6.797	6.931	7.139	4.702	4.629
14	5.481	4.212	6.538	5.695	6.572	6.353	6.901	4.583	4.602
15	5.286	4.660	5.903	5.377	5.750	6.245	6.771	4.233	4.177
16	5.745	4.839	6.624	5.724	6.378	6.553	7.298	4.843	4.764
17	5.872	4.910	6.697	5.689	6.362	6.502	7.367	4.993	4.881
18	5.941	4.946	6.702	5.627	6.295	6.414	7.397	5.068	4.953
19	5.967	4.982	6.698	5.527	6.197	6.326	7.397	5.134	4.980
20	5.953	4.928	6.669	5.422	6.089	6.223	7.367	5.106	4.971
21	5.867	4.713	6.624	5.267	5.958	5.950	7.258	5.031	4.899
22	5.330	4.516	6.087	4.719	5.383	5.727	6.424	4.674	4.430
23	5.780	4.857	6.332	5.080	5.620	5.872	7.298	4.833	4.782
24	5.977	4.946	6.631	5.154	5.797	6.005	7.417	5.012	4.944
25	6.020	5.000	6.671	5.128	5.773	5.985	7.466	5.049	4.999
26	6.030	5.000	6.674	5.107	5.723	5.945	7.466	5.087	5.017
27	6.000	4.928	6.644	5.066	5.674	5.847	7.367	5.068	4.980
28	5.742	4.355	6.468	4.722	5.473	5.419	5.851	4.965	4.827
29	5.583	4.893	5.902	4.706	5.040	5.458	7.040	4.514	4.520
30	5.986	5.000	6.611	5.023	5.551	5.771	7.347	5.049	4.917
31	6.047	5.036	6.682	5.020	5.584	5.780	7.407	5.106	4.971
32	6.067	5.036	6.690	4.999	5.551	5.741	7.447	5.115	4.999
33	6.056	5.018	6.675	4.970	5.507	5.692	7.457	5.096	4.999
34	5.957	4.731	6.582	4.851	5.434	5.407	7.298	5.049	4.944
35	5.353	4.785	5.877	4.418	4.781	5.264	6.553	4.552	4.367
36	5.988	5.018	6.460	4.818	5.310	5.567	7.308	4.993	4.953
37	6.073	5.036	6.596	4.886	5.445	5.667	7.357	5.096	5.053
38	6.101	5.000	6.592	4.898	5.451	5.667	7.387	5.115	5.062
39	6.075	4.982	6.585	4.901	5.446	5.652	7.387	5.096	5.026
40	6.017	4.910	6.540	4.874	5.427	5.618	7.337	5.049	4.971
41	5.861	4.642	6.457	4.779	5.373	5.367	7.149	4.965	4.854
42	5.229	4.552	5.766	4.335	4.789	5.283	6.424	4.467	4.277
43	5.766	4.821	6.272	4.787	5.294	5.588	7.089	4.824	4.746
44	5.789	4.803	6.385	4.882	5.436	5.718	7.059	4.927	4.800
45	5.706	4.731	6.350	4.929	5.466	5.727	6.960	4.880	4.755
46	5.566	4.570	6.282	4.958	5.481	5.712	6.861	4.758	4.629
47	5.360	4.337	6.171	4.938	5.492	5.677	5.712	4.589	4.448
48	5.040	3.961	5.979	4.846	5.467	5.501	6.424	4.336	4.177
49	4.261	3.584	5.229	4.356	4.921	5.285	5.600	3.717	3.510
50	4.361	3.548	5.481	4.727	5.294	5.438	5.937	3.754	3.609
51	4.038	3.226	5.309	4.644	5.246	5.322	5.600	3.520	3.347
52	3.600	2.832	4.912	4.306	4.994	4.993	5.074	3.163	2.986
53	3.011	2.330	4.373	3.953	4.541	4.452	4.408	2.722	2.553
54	2.321	1.649	3.671	3.342	3.902	3.671	3.535	2.177	2.003
55	1.504	1.308	2.724	2.412	2.985	2.667	2.393	1.436	1.245
56	1.456	1.057	1.905	1.921	2.136	2.122	2.025	1.671	1.579
57	.653	.197	2.198	1.849	2.508	1.448	.824	.770	.577

Axial Power Distribution (KW/FT)

Figure 7

Map 7: 90% of full power

(normalized to 2758 MW_t)

Core Locations

Axial Position	R8	N2	L13	K6	G9	F7	D3	B13	B3
1 (Top of Core)	1.343	1.399	1.612	[illegible]	4.753	4.132	1.029	1.185	1.279
2	1.232	1.332	2.028	2.762	3.867	3.747	1.984	1.290	1.144
3	1.744	1.810	2.856	3.584	3.619	4.093	2.939	1.521	1.615
4	2.411	2.[illegible]49	3.684	4.556	4.663	5.279	3.893	2.117	2.174
5	2.986	2.524	4.573	5.298	5.635	6.123	4.759	2.627	2.649
6	3.428	3.091	5.127	5.441	6.053	6.316	5.337	3.032	3.005
7	3.663	3.[illegible]91	5.305	5.699	6.291	6.744	5.367	3.046	3.174
8	4.469	4.[illegible]09	6.145	6.277	7.049	7.371	6.347	3.785	3.788
9	4.872	4.293	6.489	6.421	7.236	7.503	6.725	4.136	4.112
10	5.202	4.[illegible]22	6.695	6.443	7.287	7.526	6.956	4.404	4.369
11	5.437	4.657	6.826	6.419	7.227	7.468	7.119	4.515	4.565
12	5.586	4.[illegible]38	6.877	6.343	7.114	7.373	7.238	4.756	4.693
13	5.669	4.[illegible]52	6.856	6.213	6.967	7.200	7.282	4.812	4.733
14	5.542	4.374	6.576	5.721	6.430	6.515	7.156	4.730	4.625
15	5.338	4.711	6.201	5.601	6.227	6.607	7.275	4.319	4.443
16	5.869	4.887	6.780	5.889	6.600	6.794	7.401	4.903	4.896
17	5.966	4.954	6.815	5.854	6.537	6.706	7.460	5.037	5.004
18	6.024	5.[illegible]08	6.806	5.781	6.466	6.607	7.483	5.121	5.071
19	6.035	5.008	6.773	5.666	6.368	6.469	7.475	5.142	5.085
20	6.005	4.954	6.726	5.551	6.232	6.372	7.445	5.128	5.058
21	5.891	4.[illegible]52	6.634	5.334	5.941	6.045	7.312	5.044	4.950
22	5.280	4.[illegible]09	6.130	4.891	5.556	5.623	6.458	4.601	4.369
23	5.837	4.860	6.463	5.192	5.880	6.121	7.290	4.819	4.916
24	5.976	4.927	6.660	5.244	5.936	6.129	7.416	5.002	5.010
25	6.005	[illegible]	6.679	5.213	5.882	6.082	7.460	5.023	5.064
26	5.976	4.941	6.648	5.174	5.830	6.030	7.445	5.037	5.064
27	5.949	4.860	6.560	5.105	5.728	5.913	7.342	5.009	5.010
28	5.579	4.293	6.264	4.679	5.294	5.276	7.134	4.861	4.733
29	5.611	4.806	6.076	4.790	5.365	5.723	6.926	4.481	4.740
30	5.909	4.873	6.546	5.056	5.637	5.817	7.252	4.938	4.950
31	5.947	4.900	6.575	5.047	5.625	5.795	7.297	4.974	4.983
32	5.950	4.887	6.564	5.017	5.582	5.744	7.327	4.988	4.997
33	5.920	4.860	6.520	4.956	5.525	5.678	7.312	4.967	4.963
34	5.780	4.[illegible]76	6.258	4.751	5.227	5.341	7.171	4.896	4.875
35	5.277	4.576	5.806	4.462	5.014	5.249	6.376	4.362	4.322
36	5.825	4.819	6.345	4.796	5.403	5.617	7.134	4.833	4.950
37	5.900	4.833	6.424	4.846	5.457	5.640	7.171	4.931	5.010
38	5.908	4.819	6.418	4.849	5.450	5.614	7.200	4.938	5.004
39	5.882	4.[illegible]92	6.399	4.854	5.430	5.577	7.178	4.903	4.963
40	5.812	[illegible]25	6.345	4.836	5.399	5.552	7.134	4.854	4.896
41	5.654	4.[illegible]41	6.094	4.668	5.141	5.267	6.978	4.749	4.760
42	5.081	4.374	5.665	4.394	4.945	5.164	6.161	4.228	4.193
43	5.593	4.830	6.144	4.769	5.364	5.585	6.889	4.664	4.740
44	5.601	4.830	6.216	4.849	5.440	5.644	6.866	4.761	4.760
45	5.532	4.838	6.193	4.884	5.454	5.674	6.770	4.699	4.693
46	5.383	4.[illegible]14	6.115	4.906	5.470	5.666	6.685	4.594	4.578
47	5.181	4.212	6.006	4.897	5.479	5.637	6.547	4.432	4.376
48	4.858	3.834	5.684	4.748	5.227	5.334	6.325	4.179	4.099
49	4.126	3.[illegible]23	5.173	4.415	5.019	5.169	5.463	3.574	3.430
50	4.266	3.456	5.368	4.708	5.311	5.439	5.82[illegible]	3.651	3.586
51	3.940	3.132	5.154	4.606	5.171	5.256	5.528	3.433	3.315
52	3.492	2.754	4.731	4.326	4.845	4.902	5.040	3.0[illegible]	2.924
53	2.902	2.268	4.151	3.883	4.313	4.304	4.357	2.424	2.471
54	2.207	1.806	3.357	3.244	3.538	3.479	3.533	2.103	1.870
55	1.488	1.296	2.463	2.309	2.543	2.389	2.413	1.316	1.209
56	1.785	1.012	1.966	1.857	1.715	1.774	1.982	1.695	1.492
57 (Bottom of Core)	2.082	.216	2.219	1.963	1.498	.601	1.091	.689	1.383

Axial Power Distribution (KW/FT)

Figure 8

Map 8: 100% of full power

Core Locations

Axial Position (Top of Core to Bottom of Core)

	R8	N2	L13	K6	G9	F7	D3	B13	B3
1	1.159	1.432	1.641	2.894	3.689	5.202	1.123	1.160	1.389
2	1.422	1.435	2.853	2.803	4.230	4.191	2.130	1.390	1.247
3	2.054	2.005	2.898	3.711	3.986	4.057	3.141	1.507	1.474
4	2.731	2.548	3.751	4.642	5.115	5.217	4.148	2.098	2.336
5	3.316	2.983	4.567	5.381	6.026	6.129	4.978	2.652	2.806
6	3.653	3.079	5.313	5.527	6.273	6.358	5.452	3.110	3.078
7	4.116	3.659	5.207	5.874	6.523	6.676	5.590	3.148	3.404
8	4.749	4.058	6.188	6.402	7.254	7.377	6.499	3.796	3.929
9	5.089	4.323	6.543	6.518	7.395	7.534	6.835	4.178	4.200
10	5.380	4.529	6.766	6.529	7.419	7.528	7.052	4.445	4.436
11	5.556	4.649	6.393	6.483	7.361	7.482	7.190	4.655	4.595
12	5.692	4.722	6.958	6.391	7.222	7.384	7.269	4.807	4.689
13	5.724	4.710	6.959	6.239	7.065	7.229	7.329	4.846	4.726
14	5.422	4.299	6.854	5.695	6.477	6.618	7.072	4.826	4.454
15	5.602	4.698	5.986	5.664	6.325	6.457	6.894	4.330	4.599
16	5.907	4.842	6.773	5.948	6.665	6.795	7.457	4.903	4.870
17	5.982	4.903	6.837	5.896	6.609	6.712	7.506	5.055	4.961
18	5.009	4.951	6.827	5.805	6.530	6.626	7.487	5.132	5.015
19	6.003	4.927	6.819	5.695	6.421	6.517	7.487	5.151	5.015
20	5.944	4.867	6.757	5.574	6.281	6.412	7.447	5.132	4.943
21	5.788	4.661	6.705	5.268	6.006	6.131	7.329	5.055	4.780
22	5.255	4.432	6.186	5.025	5.549	5.726	5.420	4.750	4.291
23	5.884	4.794	6.334	5.231	5.956	6.086	7.269	4.750	4.352
24	5.965	4.842	6.654	5.283	5.999	6.160	7.388	4.960	4.943
25	5.971	4.857	6.663	5.249	5.961	6.117	7.447	4.998	4.961
26	5.935	4.867	6.646	5.217	5.891	6.075	7.447	5.017	4.961
27	5.668	4.770	6.595	5.145	5.786	5.957	7.329	4.998	4.870
28	5.238	4.227	6.397	4.730	5.318	5.483	6.795	4.922	4.382
29	5.732	4.710	5.735	4.850	5.408	5.557	5.394	4.369	4.726
30	5.857	4.762	6.488	5.080	5.682	5.830	7.190	4.903	4.634
31	5.874	4.794	6.542	5.076	5.655	5.807	7.250	4.950	4.634
32	5.863	4.782	6.542	5.044	5.626	5.781	7.250	4.960	4.634
33	5.830	4.758	6.507	4.992	5.568	5.715	7.250	4.941	4.780
34	5.600	4.504	6.409	4.703	5.275	5.436	7.111	4.865	4.635
35	5.357	4.468	5.705	4.576	5.029	5.230	5.262	4.426	4.582
36	5.782	4.734	6.241	4.852	5.470	5.620	7.052	4.731	4.816
37	5.830	4.734	6.384	4.885	5.502	5.654	7.131	4.865	4.634
38	5.830	4.722	6.393	4.894	5.483	5.634	7.151	4.903	4.634
39	5.787	4.698	6.376	4.892	5.464	5.618	7.131	4.846	4.780
40	5.701	4.625	6.321	4.864	5.427	5.573	7.072	4.826	4.726
41	5.476	4.359	6.241	4.627	5.175	5.323	6.934	4.731	4.545
42	5.098	4.287	5.625	4.506	4.961	5.165	5.143	4.330	4.182
43	5.540	4.553	6.054	4.812	5.400	5.578	5.355	4.540	4.581
44	5.519	4.529	6.206	4.869	5.491	5.688	5.335	4.593	4.581
45	5.444	4.456	6.177	4.923	5.512	5.715	6.756	4.555	4.526
46	5.283	4.335	6.123	4.947	5.543	5.724	6.637	4.578	4.363
47	5.083	4.154	6.031	4.938	5.537	5.675	5.539	4.407	4.164
48	4.706	3.804	5.869	4.753	5.325	5.435	6.321	4.197	3.875
49	4.156	3.466	5.199	4.532	5.048	5.229	5.492	3.701	3.404
50	4.195	3.405	5.409	4.772	5.359	5.490	5.867	3.644	3.458
51	3.653	3.104	5.290	4.641	5.239	5.357	5.590	3.491	3.168
52	3.384	2.717	4.917	4.372	4.926	5.061	5.096	3.148	2.788
53	2.775	2.270	4.410	3.893	4.397	4.528	4.405	2.725	2.295
54	2.005	1.654	3.715	3.202	3.626	3.731	3.536	2.232	1.666
55	1.557	1.268	2.796	2.254	2.589	2.722	2.459	1.469	1.195
56	1.485	1.002	1.899	1.984	2.296	2.336	1.977	1.583	1.086
57	1.045	.205	2.264	1.371	2.641	2.301	[illegible]	.858	.978

Q. What was the numerial value of the axial offset when each of the eight maps was taken?

A. The values of axial offset for Maps #1 through #8 are as follows:

Map #	Power Level (%)	Axial Offset(%)
1	~2	35.38
2	35	-0.77
3	70	9.36
4	70	-10.28
5	70	16.65
6	70	2.81
7	90	4.27
8	100	4.99

12. Q. What was the numerical value of the core inlet temperature when Maps 1 through 7 were taken?

A. Core Inlet temperature for Maps 1 through 7, as measured by narrow range Resistance Temperature Detectors (RTD's) are as follows:

Map #1	Core Inlet Temperature (°F)
1	539
2	540
3	539
4	541
5	541
6	541*
7	527

*Estimated based upon using Tavg = 559°F at 2-3 hrs before Map 6 was taken.

13. Q. Provide a quantitative estimate for radial power distribution flattening due to xenon poisoning and due to depletion for maps 4 and 8.

A. Quantitative estimates of the effects of Xenon poisoning and depletion on core radial power distribution at Map 4 and 8 conditions are not available. Map 4 was taken in a transient condition about two hours after a deep control rod insertion (C/D at 180 steps) in order to produce a large negative axial offset for the purpose of excore-incore axial offset calibration. Map 8 represents the first normal, full power operation, monthly map after the startup tests. It was taken to verify that peaking factors are within Technical Specification limits. These maps did not require detailed calculations to determine Xenon effects on the radial power distribution. The depletion effect on the radial power distribution for these maps is insignificant. Therefore we do not have such calculations on hand.

In lieu of quantitative estimates for radial power distribution flattening for Maps 4 and 8, We have attached figure 9 which gives the percentage difference between the average assembly-wise power distributions for the Beginning of Life (BOL), Hot Full Power (HFP), No Xenon and the HFP Equilibrium Xenon, 150 MWD/MTU conditions. Figure 9, therefore, depicts the effect on radial power distribution due to Xenon poisoning and due to depletion representative of the beginning of life of Cycle 2.

FIGURE 9

PERCENT DIFFERENCE BETWEEN BOL-HFP-NO XENON
AND BOL-HFP-EQXE AVERAGE ASSEMBLYWISE POWER DISTRIBUTIONS

	8	7	6	5	4	3	2	1
H	-8.80							
G	-8.10	-8.0						
F	-7.50	-6.90	-6.40					
E	-4.90	-5.0	-4.10	-2.90				
D	-2.90	-1.90	-1.0	- .50	- .30			
C	+ .30	+ .60	+2.30	+1.20	+2.20	+3.80		
B	+2.50	+3.90	+2.80	+3.80	+3.80	+3.60		
A	+4.30	+4.50	+4.10	+3.40				

T

B

In/out Tilt

$\Delta P_T = -4\%$

$\Delta P_B = +3\%$

Figure 9 (Continued)

Figure 9 presents the effects on the assembly average power distribution of:

(1) Xenon poisoning
(2) depletion

The power distributions are calculated for 0 MWD/MTU, No Xenon, and 150 MWD/MTU, Equilibrium Xenon at HFP-ARO conditions.

The percent differences were calculated as follows:

$$\left[\frac{P_{NOXE\ (0\ MWD/MTU)} - P_{EQXE\ (150\ MWD/MTU)}}{P_{EQXE\ (150\ MWD/MTU)}}\right] \times 10^2$$

The in/out tilt calculation is based upon the summation of the assembly average powers as follows:

$$\Delta P_T = \sum_{i=1}^{5} \sum_{j=1}^{5} \Delta P_{ij} * f_{ij}$$

$$\Delta P_B = \sum_{i=6}^{8} \sum_{j=1}^{6} \Delta P_{ij} * f_{ij}$$

$$\sum_{ij=1,1}^{5,5} f_{ij_T} = 10.125, \quad \sum_{i,j=6,1}^{8,6} f_{ij_B} = 14.0$$

where:

i = row

j = column

f_{ij} = fraction of assembly in 1/8th core geometry

ΔP_{ij} = % Difference No Xenon/EQXE

14. Q. Describe the methods that were used to verify (visually or otherwise) the placement of the fuel assemblies and the placement of the burnable poison clusters. Which methods were rechecked after the first power map was taken?

A. The verification of the placement of the fuel assemblies and the placement of the assembly inserts (i.e. burnable poison assembly, etc) was carried out at three levels.

(i) First Level Verification -

The first level verification was carried out according to IP-2 Cycle 2 Loading Procedure SOP 17.2. This procedure provided the instructions for the step by step movement of each fuel assembly including the removal and insertion of burnable poison rod assemblies or thimble plugs. Specifically, the procedure SOP 17.2 was used to control the following:

a) movement of fuel assemblies from the core to specific locations in the spent fuel pit,

b) the removal or replacement of burnable poison rod assemblies, thimble plugs, and other inserts in the fuel assemblies.

c) relocation of the remaining fuel in the core to the new locations,

d) Movement and final placement in the core of used fuel assemblies and new fuel assemblies.

Procedure SOP 17.2 was followed in a step by step manner and each step was checked off when completed. Where changes in sequence were required, these changes were covered by approved procedure changes. Other plant procedures govern the review, approval and implementation of any changes to the Cycle 2 Loading Procedure.

When fuel assemblies were transported from the fuel storage building through the transfer tube into the containment, procedure SOP 17.2 required visual confirmation of each fuel assembly identification number while each fuel assembly passed through the upender in the fuel storage building. Although it was not required by the procedure, this identification was again verified when the fuel assembly reached the upender in the containment building.

(ii) Second Level Verification -

The second level verification was carried out according to IP-2 Cycle 2 Procedure SOP 17.20. This procedure provided for a visual verification that each fuel assembly and assembly insert were correctly placed in the core in accordance with the design core loading patterns given in SOP 17.20.

This procedure utilized video equipment provided by Westinghouse. The verification was conducted by moving the camera from one fuel assembly to another to confirm the fuel assembly identification number and orientation and the identification number and orientation of the assembly insert. The core loading pattern sheet of SOP 17.20 was checked off as each item was confirmed. A video and audio recording was made of this inspection.

(iii) Third Level Verification -

As a third level of verification, the video tape and audio recording were reviewed immediately after the live video inspection. This review revealed no discrepancies from the design loading pattern.

On September 22, 1976 an incore flux map was taken with the reactor at HZP and BOL conditions. Subsequent to that flux map, the third level verification was re-reviewed. No discrepancies were observed.

15. Q. Were any low power maps taken since Map 1? If so, provide the low power map and high power, equilibrium xenon map at approximately the same burnup. Also give the approximate value of the xenon poisoning for the low power map.

A. No low power ($<$ 35%) maps were taken since Map 1.