MASTER

DUQUESNE LIGHT COMPANY
SHIPPINGPORT ATOMIC POWER STATION

DLCS 1510109
T-550132

MEASUREMENT OF COEFFICIENTS OF REACTIVITY

0 EFPH

CORE I SEED 2

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Section 1 of 2 Sections

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TEST RESULTS

DLCS 1510109

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O EFPH

CORE I SEED 2

Purpose

To determine the temperature and pressure coefficients of reactivity at zero power.

Conclusion

The temperature and pressure coefficients of reactivity at zero power and at the operating temperature and pressure of 500 F and 1785 psig were $-2.20 \times 10^{-4} \Delta\rho/\Delta T$ and $2.50 \times 10^{-6} \Delta\rho/\Delta P$, respectively.

Description of Test Equipment and Test Procedure

The test began at 1730 hours on April 19, 1960, with an average reactor coolant temperature of 133 F. Data for the temperature coefficient was obtained as outlined in the test procedure from this temperature to an average reactor coolant temperature of 200 F. Three reactor coolant pumps (1A, 1B and 1C) operating on SLOW speed were used to increase the reactor coolant temperature. The "cold" portion of the test was terminated at 1450 hours on April 20, 1960, for additional cold plant testing.

Because of the limitation placed on the reactor coolant pumps as to when they can be run on fast speed and because of the time needed to heat the reactor coolant loops with the pumps on slow speed, reactor heat was used to supplement the mechanical heat input of the pumps to increase the reactor coolant loop temperature.

On April 25, 1960, at 1953 hours, criticality was attained and reactor heat was used to raise the average reactor coolant temperature from approximately 283 F to 430 F. At this point, the reactor was shutdown and the 1A, 1C and 1D reactor coolant pumps were placed on FAST speed. The average reactor coolant temperature was maintained at 430 F and fission counters, used with the scalars to determine startup rates, were reinstalled. These had previously been removed when the reactor was being used to heat up the Reactor Coolant System. Starting at 0945 hours on April 26, 1960, pressure and temperature coefficient data were obtained as the system temperature and pressure were alternately increased from 434 F to 514 F and from 1240 psig to 1800 psig respectively. At 0204 hours on April 27, 1960 the test was terminated, but inconsistent data (Runs No. 20 - 24, Table VI) recorded during the latter portion of the test necessitated repeating several runs. These were reperformed from 2215 to 2314 hours on April 27, 1960, when the test was finally terminated.

TEST RESULTS DLCS 1510109

T-550132

MEASUREMENT OF COEFFICIENTS OF REACTIVITY

Results

DLCS 1510109 was started on April 19, 1960, and completed on April 27, 1960. During this initial performance at 0 EFPH for Core I, Seed 2, a temperature coefficient of $2.20 \times 10^{-4} \Delta\rho/\Delta T$ and a pressure coefficient of $2.50 \times 10^{-6} \Delta\rho/\Delta P$ were determined at normal operating conditions of 500 F and 1785 psig.

In the first or cold portion of this test, data were recorded for the temperature coefficient from 133 F to 200 F and listed in Tables I through V. Figures 1 and 2 are graphs showing plots of reactivity versus reactor coolant temperature for this temperature range. The figures also show the temperature coefficient calculations as determined from the plotted data.

In the second or hot portion of the test, both pressure and temperature coefficient data were recorded. Data for the temperature coefficient were obtained by holding the system pressure constant at approximately 1200 psig and increasing the system temperature from approximately 430 F to 450 F with three reactor coolant pumps on fast speed. After completion of this part of the test, the temperature was held constant at $450 + 1/2$ F and the reactor coolant system pressure was raised from 1200 psig to 1800 psig in 100 psig increments and pressure coefficient data were recorded. The pressure was then held constant at approximately 1800 psig and the reactor coolant temperature was increased from 450 F to 510 F and temperature coefficient data were recorded. All data recorded during this portion of the test are listed in Tables VI thru XI.

Figures 3 through 8 are plots of reactivity versus reactor coolant temperature as obtained from the data in Table VI. The figures also show the temperature coefficient calculations as determined from the plotted data. These calculated values of temperature coefficient along with the values obtained from Figures 1 and 2 were plotted versus reactor coolant temperature as shown in Figure 9.

Figure 10 is a plot of reactivity versus reactor coolant pressure. The pressure coefficient was calculated to be $1.79 \times 10^{-6} \Delta\rho/\Delta P$ at 450 F. By using the correction curve in Figure 11, the pressure coefficient was calculated to be $2.50 \times 10^{-6} \Delta\rho/\Delta P$ at 500 F. The pressure coefficient was constant over the range of pressure tested, varying only with reactor coolant temperature as shown in Figure 11.

In determining the pressure coefficient, reactivity measurements were corrected for temperature variations to a base temperature of 450 F by using the temperature coefficient at 450 F obtained from Figure 9.

In determining the temperature coefficients, no corrections were made to the reactivity values due to pressure variations. The average pressure variation during the second or hot portion of this test was approximately 11 psig, the maximum pressure variation during a temperature coefficient run being 24 psig and the minimum being 2 psig. The pressure was determined by averaging the individual pressure indicator readings of the operating reactor coolant loops for each run. The greatest pressure variations occurred during runs 1 through 5 as

TEST RESULTS DLCS 1510109

T-550132

MEASUREMENT OF COEFFICIENTS OF REACTIVITY

indicated in the data in Table VI and plotted in Figure 3. It can be seen that correcting for pressure variations does not change the slope of the temperature coefficient curve. Since the pressure variations are even less for the other runs, there is no change in the temperature coefficients due to pressure corrections. It should be noted that even though the ratio of the temperature coefficient to the pressure coefficient is approximately 100 to 1, pressure variations are often greater than temperature variations by a factor of 100 or more, making pressure corrections as significant as temperature corrections in these cases.

All reactivity values in these results were obtained from reactivity tables calculated with $\beta^{25} = 0.0064$. No β/β^{25} corrections were used. Additional required data, recorded during reactor plant warm-up, are listed in Tables XII through XIV.

The bank configurations used throughout this test consisted of rod sub-groups 1, 2, 3, 5, 6 and 7 with rod sub-group 6 controlling for the first part of this test for reactor coolant temperatures from 130 F to 260 F and with rod sub-group 2 controlling for the remainder of the test. Groups III and IV rods remained at 1 inch throughout the test.

FIGURE 2
Reactivity (ρ) vs. Temperature (F)
Runs 23 thru 27
Date: 4/20/60

FIGURE 3

Reactivity (ρ) vs. Temperature (F)

Runs 1 thru 5

Date: 4/26/60

$\rho \times 10^{-4}$

$$\begin{aligned}\frac{\Delta \rho}{\Delta T} &= - \frac{\rho_1 - \rho_2 \times 10^{-4}}{T_2 - T_1} \\ \frac{\Delta \rho}{\Delta T} &= - \frac{18 - 2}{444.5 - 435.2} \times 10^{-4} \\ &= - \frac{16}{9.3} \times 10^{-4} \\ &= - 1.720 \times 10^{-4} \text{ at } 439.8 \text{ F}\end{aligned}$$

433 34 35 36 37 38 39 40 41 42 43 44 45 46

Temperature F

FIGURE 8
Reactivity (ρ) vs. Temperature (F)
Runs 29 thru 31
Date: 4/27/60

$$\begin{aligned}\frac{\Delta\rho}{\Delta T} &= - \frac{18 - 10}{512.4 - 509.2} \times 10^{-4} \\ &= - \frac{8}{3.2} \times 10^{-4} \\ &= - 2.500 \times 10^{-4} \text{ at } 510.8 \text{ F}\end{aligned}$$

FIGURE 10
Reactivity (ρ) vs. Pressure
Runs 6 thru 12
Date: 4/26/60

$$\frac{\Delta \rho}{\Delta P} = \frac{\rho_1 - \rho_2}{P_1 - P_2} \times 10^{-4} \text{ at } \frac{P_1 + P_2}{2}$$

$$\frac{\Delta \rho}{\Delta P} = \frac{14.5 - 6.5}{1728 - 1280} \times 10^{-4} \text{ at } \frac{1728 + 1280}{2}$$

$$\frac{\Delta \rho}{\Delta P} = 8.0 \times 10^{-4}$$

$$\frac{\Delta \rho}{\Delta P} = 1.786 \times 10^{-6} \text{ at } 450^\circ\text{F}$$

VARIATION OF PRESSURE COEFFICIENT WITH TEMPERATURE CHANGE

FIGURE 11

TABLE I
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Time Base Sec
						Counts	Ratio	Counts	Ratio				
4/19/60	1	1908:12	134.45	475	11.55	14752		12488		1.63	1.272	18.002	10
						24010	1.63	19816	1.59				
						41167	1.71	32306	1.63				
						69013	1.68	50934	1.58				
								81189	1.59				
	2	1920:02	134.65	495	11.55	14858		12739		1.66	1.319	18.353	10
						24652	1.66	20801	1.63				
						43128	1.75	33975	1.63				
						74428	1.73	54376	1.60				
								88238	1.62				
	3	1931:18	135.05	495	11.55	15206		13029		1.63	1.272	18.002	10
						24266	1.60	20974	1.61				
						41424	1.71	32829	1.57				
						70323	1.70	52938	1.61				
								83788	1.58				
	4	1942:28	136.15	510	11.55	14644		12736		1.62	1.256	17.877	10
						23649	1.61	19877	1.56				
						39807	1.68	32408	1.63				
						67708	1.70	50546	1.56				
								79673	1.58				
	5	1959:44	137.35	455	11.55	11338		15042		1.54	1.123	16.814	10
						17647	1.56	22250	1.48				
						26788	1.52	34156	1.54				
						44056	1.64	51594	1.51				
						70242	1.59	77604	1.50				
	6	2022:03	138.95	495	11.55	14825		12907		1.51	1.074	16.399	10
						22300	1.50	19386	1.50				
						34443	1.54	28161	1.45				
						55483	1.61	42967	1.53				
						83998	1.51	63402	1.48				
								94481	1.49				

TABLE I (cont'd)
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Time Base Sec
						Counts	Ratio	Counts	Ratio				
4/19/60	7	2040:48	140.35	445	11.55	13159		11341		1.47	1.003	15.774	10
						19184	1.46	16621	1.47				
						28032	1.46	24254	1.46				
						42682	1.52	34798	1.43				
						65255	1.53	50226	1.44				
						94902	1.45	72251	1.44				
	8	2103:33	141.9	463	11.55	13986		11946		1.43	.933	15.123	10
						19488	1.39	17049	1.43				
						28024	1.44	24355	1.43				
						42184	1.51	34080	1.40				
						63219	1.50	48679	1.43				
	9	2126:37	143.3	510	11.55	89444	1.41	67973	1.40				
								96912	1.43				
						11174		19553		1.96	.876	14.576	20
						22236	1.99	37971	1.94				
						44069	1.98	72253	1.90				
						91464	2.08	136882	1.89				
						179828	1.97						
	10	2156:10	145.1	455	11.55	14793		12697		1.88	.822	14.027	20
						27604	1.87	23405	1.84				
						51644	1.87	43924	1.88				
						103839	2.01	80312	1.83				
	11	2221:52	146.65	500	11.55	198244	1.91	148489	1.85				
						10447		16156		1.84	.795	13.748	20
						19057	1.82	29417	1.82				
						34658	1.82	52961	1.80				
						65124	1.88	95072	1.80				
						127896	1.96	171153	1.80				

TABLE I (cont'd)
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _C F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/19/60	12	2245:05	147.7	445	11.55	12093		10688		1.71	.698	12.675	20
						20560	1.70	17988	1.68				
						34914	1.70	30786	1.71				
						60576	1.74	51438	1.67				
						109328	1.80	87264	1.70				
						189927	1.74	146562	1.68				
	13	2312:38	149.4	430	11.55	18482		16326		2.02	.611	11.642	30
						37328	2.02	32278	1.98				
						74564	2.00	64756	2.01				
						160209	2.15	129859	2.01				
								258318	1.99				
	14	2334:15	150.4	455	11.55	14422		12578		1.99	.598	11.476	30
						28410	1.97	25140	2.00				
						55902	1.97	48908	1.95				
						112682	2.02	96665	1.98				
						238894	2.12	189183	1.96				
4/20/60	15	0030:36	154.23	455	11.55	12733		10784		1.75	.487	10.003	30
						21983	1.73	18907	1.75				
						38243	1.74	32744	1.73				
						64775	1.72	56920	1.74				
						118146	1.80	97772	1.72				
						218732	1.85	169900	1.74				
	16	0114:38	156.83	455	11.55	10654		15035		1.63	.424	9.086	30
						17323	1.63	24707	1.64				
						27999	1.62	40308	1.63				
						45507	1.63	64476	1.60				
						73547	1.62	103898	1.61				
						123865	1.68	168597	1.61				
						211486		271038					

TABLE I (cont'd)
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/20/60	17	0143:45	158.37	458	11.55	10608		14030		1.53	0.369	8.214	30
						16253	1.53	21419	1.53				
						24570	1.51	32773	1.53				
						37644	1.53	50101	1.53				
						57094	1.52	76480	1.52				
						87524	1.53	116298	1.52				
						139933	1.60	176735	1.51				
						222577	1.59	266012					
	18	0214:47	160.14	475	11.55	10608		15520		1.67	0.334	7.631	40
						17834	1.68	26054	1.68				
						30099	1.69	43354	1.66				
						50449	1.68	71424	1.68				
						83624	1.66	120679	1.65				
						141708	1.69	198636	1.65				
						250432		328135					
4/20/60	19	0255:51	162.4	470	11.55	11283		14589		1.49	0.259	6.284	40
						16958	1.50	21841	1.50				
						25243	1.49	32974	1.51				
						37809	1.50	48895	1.48				
						56607	1.50	72553	1.48				
						84149	1.49						
	20	0253:39	165.28	438	11.55	12199		10389		1.35	0.196	5.027	40
						16186	1.33	14179	1.36				
						22053	1.36	19065	1.34				
						29309	1.33	26077	1.37				
						39985	1.36	34724	1.33				

TABLE I (cont'd)
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _C F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity ρ x 10 ⁻⁴	Base Sec									
						Counts	Ratio	Counts	Ratio													
4/20/60	21	0443:12	168.43	438	11.55	11107		12132		1.25	0.145	3.908	40									
						13866	1.25	14877	1.23													
						17653	1.27	18759	1.26													
						21561	1.22	23181	1.24													
						27283	1.27	29076	1.25													
						33629	1.23															
	22	054733	171.57	463	11.55	10124		10066		1.11	0.078	2.368	40									
						11265	1.11	11044	1.10													
						12732	1.13	12496	1.13													
						14498	1.09	13883	1.11													
						15769	1.09	15661	1.13													
						17924	1.14															
						Temperature Override at 0706:00 of 4/20/60																
						23	0850:40	180.6	448					11.77	10369	1.24	10887	1.20	1.23	0.539	10.715	10
	12829	1.21	13045	1.20																		
	15482	1.21	15682	1.24																		
	18675	1.23	19464	1.22																		
	22932	1.23	23660	1.23																		
	28163	1.26	29021	1.21																		
	35457	1.27	35110	1.22																		
	44989	1.24	42781	1.22																		
	55769	1.24	52030	1.23																		
	69204	1.22	63846	1.21																		
	84510		77058	1.22																		
			93698																			
	24	092840	183.7	473	11.77					13923	1.40	11591	1.42		1.41	0.448	9.435	20				
										19503	1.40	16433	1.40									
						27277	1.41	22969	1.39													

TABLE I (cont'd)
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/20/60	25	1029:15	186.2	485	11.77	38352	1.41	32034	1.42	1.75	0.365	8.155	40
						53888	1.47	45585	1.40				
						79216	1.45	63781	1.41				
						115528	1.43	89633	1.39				
						165596		124499					
						10949	1.72	15858	1.74				
						18789	1.76	27649	1.75				
						33064	1.73	48409	1.75				
						57106	1.76	84546	1.74				
						100794	1.77	146945	1.72				
4/20/60	26	1127:50	189.2	485	11.77	178560	1.83	252862		1.52	0.273	6.549	40
						327454		437986					
						558523							
						10942	1.50	14008	1.50				
						16435	1.53	21049	1.52				
						25070	1.52	31903	1.51				
						38129	1.50	48200	1.53				
						57159	1.51	73663	1.49				
						86322	1.53	109743	1.50				
						132201	1.60	164291	1.50				
	27	1252:40	193.7	488	11.77	211285	1.60	246358	1.49	1.28	0.160	4.250	40
						336954		367148					
						12838	1.29	10858	1.29				
						16597	1.27	13984	1.33				
						21114	1.31	18600	1.24				
						27613	1.29	23027	1.30				
						35698	1.28	29945	1.30				
						45868	1.27	38859	1.26				
						58377	1.25	48994	1.28				

TABLE I (cont'd)
TEMPERATURE COEFFICIENT

Date	Run No.	Assigned Time	Avg Temp-T _C F	Avg. Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
						73132	1.29	62796	1.27				
						94227	1.28	79846	1.28				
						120685	1.30	102434	1.27				
						157464	1.33	129621	1.27				
						209752	1.33	165216	1.26				
						278045	1.28	208839	1.26				
						355355		264158	1.26				
								333027					

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

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TABLE II

TEMPERATURES - MUELLER BRIDGES

Date	Run No.	Time	1A Tc		1C Tc		1D Tc		Avg. Tc F
			Ω	F	Ω	F	Ω	F	
4/19/60		1730	30.54	132.7	30.54	132.8	OOS	OOS	132.75
		1745	30.56	133.0	30.56	133.1	-	-	133.05
		1800	30.58	133.4	30.57	133.3	-	-	133.35
		1815	30.59	133.6	30.59	133.7	-	-	133.65
		1830	30.61	134.0	30.60	133.9	-	-	133.95
		1845	30.62	134.1	30.61	134.1	-	-	134.10
		1850	30.63	134.3	30.62	134.2	-	-	134.25
		1900	30.63	134.3	30.63	134.4	-	-	134.30
	1	1907	30.64	134.5	30.63	134.4	-	-	134.45
	2	1949.5	30.65	134.7	30.64	134.6	-	-	134.65
	3	1930.5	30.67	135.1	30.66	135.0	-	-	135.05
	4	1940.5	30.73	136.2	30.72	136.1	-	-	136.15
	5	1957	30.79	137.3	30.79	137.4	-	-	137.35
	6	2020	30.88	138.9	30.88	139.0	-	-	138.95
	7	2039	30.95	140.3	30.95	140.4	-	-	140.35
	8	2103	31.04	141.9	31.03	141.9	-	-	141.90
	9	2123	31.11	143.2	31.11	143.3	-	-	143.25
	10	2152	31.21	145.1	31.21	145.1	-	-	145.10
	11	2218	31.30	146.7	31.29	146.6	-	-	146.65
	12	2240	31.37	148.0	31.37	148.0	31.30	147.6	147.70
	13	2310	31.46	149.6	31.46	149.7	31.39	149.2	149.40
	14	2330	31.52	151.0	31.52	150.8	31.46	150.4	150.40
4/20/60	15	0030	31.92	154.3	31.715	154.3	31.665	154.1	154.23
	16	0115.5	31.87	157.1	31.865	157.1	31.78	156.3	156.83
	17	0144.5	31.945	158.5	31.945	158.6	31.875	158.0	158.37
	18	0214.5	32.05	160.45	32.035	160.3	31.965	159.68	160.14
	19	0255.5	32.165	162.6	32.155	162.5	32.095	162.1	162.40
	20	0353.4	32.325	165.5	32.31	165.35	32.25	165.0	165.28
	21	0443.1	32.49	168.6	32.485	168.6	32.42	168.1	168.43
	22	05473	32.665	171.8	32.65	171.65	32.59	171.25	171.57
		0706	32.893	176.05	32.89	176.1	32.82	175.5	175.55
	23	0850.67	33.158	181.2	33.165	181.4	33.01	179.2	180.60
	24	0928.67	33.27	183.2	33.27	183.3	33.20	182.7	183.70
	25	1029.25	33.43	186.35	33.43	186.45	33.36	185.6	186.20
	26	1127.83	33.58	189.3	33.58	189.4	33.51	188.8	189.20
	27		33.82	193.8	33.82	193.9	33.75	193.3	193.70
	28	1325	33.90	195.1	33.90	195.1	33.30	183.7	191.30
	29	1400	34.00	197.0	34.00	197.0	33.92	195.5	196.50

DUQUESNE LIGHT COMPANY
POWER STATIONS-DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE III

Control Rod Positions (inches) - Aux. Rod Control Panel

DATE: April 19, 1960

Run No.	-	1	2	3	4	5	6	7	8
Time	1850	1906	1919	1930	1941	1959	2022	2040	2100
Rod No.									
11	11.41	11.55	-----	-----	-----	-----	-----	-----	-----
12	11.42	11.56	-----	-----	-----	-----	-----	-----	-----
13	11.44	11.58	-----	-----	-----	-----	-----	-----	-----
14	11.42	11.55	-----	-----	-----	-----	-----	-----	-----
21	11.43	11.58	-----	-----	-----	-----	-----	-----	-----
22	11.36	11.50	-----	-----	-----	-----	-----	-----	-----
23	11.42	11.56	-----	-----	-----	-----	-----	-----	-----
24	11.41	11.55	-----	-----	-----	-----	-----	-----	-----
31	11.41	11.58	-----	-----	-----	-----	-----	-----	-----
32	11.37	11.54	-----	-----	-----	-----	-----	-----	-----
33	11.39	11.55	-----	-----	-----	-----	-----	-----	-----
34	11.45	11.62	-----	-----	-----	-----	-----	-----	-----
41	1.03	1.03	-----	-----	-----	-----	-----	-----	-----
42	0.97	0.97	-----	-----	-----	-----	-----	-----	-----
43	1.07	1.07	-----	-----	-----	-----	-----	-----	-----
44	0.97	0.97	-----	-----	-----	-----	-----	-----	-----
51	11.35	11.49	-----	-----	-----	-----	-----	-----	-----
52	11.34	11.48	-----	-----	-----	-----	-----	-----	-----
53	11.42	11.55	-----	-----	-----	-----	-----	-----	-----
54	11.36	11.49	-----	-----	-----	-----	-----	-----	-----
61	11.47	11.63	-----	-----	11.64	11.63	-----	-----	11.62
62	11.50	11.67	-----	-----	-----	-----	11.66	-----	11.65
63	11.46	11.62	-----	-----	-----	-----	11.61	11.62	11.61
64	11.41	11.56	-----	-----	11.57	-----	11.56	11.57	11.56
71	11.38	11.54	-----	-----	-----	-----	-----	-----	-----
72	11.45	11.60	-----	-----	-----	-----	-----	-----	-----
73	11.40	11.55	-----	-----	-----	-----	-----	-----	-----
74	11.31	11.47	-----	-----	-----	-----	-----	-----	-----
81	0.99	0.99	-----	-----	-----	-----	-----	-----	-----
82	0.91	0.91	-----	-----	-----	-----	-----	-----	-----
83	1.00	1.00	-----	-----	-----	-----	-----	-----	-----
84	0.94	0.94	-----	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE III (cont'd)

Control Rod Positions (inches) - Aux. Rod Control Panel

DATE: April 19 and 20, 1960

Run No.	9	10	11	12	13	14	15	16	17	18
Time	2125	2153	2220	2245	2312	2330	0025	0111	0142	0213
Rod No.										
11	11.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
12	11.56	-----	-----	-----	-----	-----	-----	-----	-----	-----
13	11.58	-----	-----	-----	-----	-----	-----	-----	-----	-----
14	11.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
21	11.58	-----	-----	-----	-----	-----	-----	-----	-----	-----
22	11.50	-----	-----	-----	-----	-----	-----	-----	-----	-----
23	11.56	-----	-----	-----	-----	-----	-----	-----	-----	-----
24	11.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
31	11.58	-----	-----	-----	-----	-----	-----	-----	-----	-----
32	11.54	-----	-----	-----	-----	-----	-----	-----	-----	-----
33	11.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
34	11.62	-----	-----	-----	-----	-----	-----	-----	-----	-----
41	1.03	-----	-----	-----	-----	-----	-----	-----	-----	-----
42	0.97	-----	-----	-----	-----	-----	-----	-----	-----	-----
43	1.07	-----	-----	-----	-----	-----	-----	-----	-----	-----
44	0.97	-----	-----	-----	-----	-----	-----	-----	-----	-----
51	11.49	-----	-----	-----	-----	-----	-----	-----	-----	-----
52	11.48	-----	-----	-----	-----	-----	-----	-----	-----	-----
53	11.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
54	11.49	-----	-----	-----	-----	-----	-----	-----	-----	-----
61	11.63	-----	11.64	11.63	-----	-----	-----	11.64	-----	-----
62	11.66	-----	11.67	11.66	-----	11.67	11.66	11.67	-----	-----
63	11.62	11.63	11.62	11.61	-----	11.62	11.61	11.63	-----	-----
64	11.56	11.57	-----	11.56	-----	11.57	11.56	11.57	-----	-----
71	11.54	-----	-----	-----	-----	-----	-----	-----	-----	-----
72	11.60	-----	-----	-----	-----	-----	-----	-----	-----	-----
73	11.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
74	11.47	-----	-----	-----	-----	-----	-----	-----	-----	-----
81	0.99	-----	-----	-----	-----	-----	-----	-----	-----	-----
82	0.91	-----	-----	-----	-----	-----	-----	-----	-----	-----
83	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----
84	0.94	-----	-----	-----	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE III (cont'd)

Control Rod Positions (inches) - Aux. Rod Control Panel

Date: April 20, 1960

Run No.	19	20	21	22	23	24	25	26	27	28	29
Time	0254	0355	0431	0534	0845	0927	1027	1127		1325	1437
Rod No.											
11	11.55	-----	-----	-----	11.71	-----	-----	-----	-----	-----	-----
12	11.56	-----	-----	-----	11.72	-----	-----	-----	-----	-----	-----
13	11.58	-----	-----	-----	11.74	-----	-----	-----	-----	-----	-----
14	11.55	-----	-----	-----	11.71	-----	-----	-----	-----	-----	-----
21	11.58	-----	-----	-----	11.73	-----	-----	-----	-----	-----	-----
22	11.50	-----	-----	-----	11.60	-----	-----	-----	-----	-----	-----
23	11.56	-----	-----	-----	11.71	-----	-----	-----	-----	-----	-----
24	11.55	-----	-----	-----	11.70	-----	-----	-----	-----	-----	-----
31	11.58	-----	-----	-----	11.72	-----	-----	-----	-----	-----	-----
32	11.54	-----	-----	-----	11.67	-----	-----	-----	-----	-----	-----
33	11.55	-----	-----	-----	11.69	-----	-----	-----	-----	-----	-----
34	11.62	-----	-----	-----	11.76	-----	-----	-----	-----	-----	-----
41	1.03	-----	-----	-----	1.30	-----	-----	-----	-----	-----	-----
42	0.97	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
43	1.07	-----	-----	-----	1.80	-----	-----	-----	-----	-----	-----
44	0.97	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
51	11.49	-----	-----	-----	11.62	-----	-----	-----	-----	-----	-----
52	11.48	-----	-----	-----	11.61	-----	-----	-----	-----	-----	-----
53	11.55	-----	-----	-----	11.68	-----	-----	-----	-----	-----	-----
54	11.49	-----	-----	-----	11.62	-----	-----	-----	-----	-----	-----
61	11.64	-----	-----	-----	11.75	11.76	-----	-----	-----	-----	-----
62	11.67	-----	11.68	11.66	11.79	-----	-----	-----	-----	-----	-----
63	11.62	-----	-----	11.67	11.76	11.75	-----	-----	-----	-----	-----
64	11.57	-----	-----	11.56	11.69	-----	11.70	-----	11.69	-----	11.70
71	11.54	-----	-----	-----	11.68	-----	-----	-----	-----	-----	-----
72	11.60	-----	-----	-----	11.74	-----	-----	-----	-----	-----	-----
73	11.55	-----	-----	-----	11.70	-----	-----	-----	-----	-----	-----
74	11.47	-----	-----	-----	11.60	-----	-----	-----	-----	-----	-----
81	0.99	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
82	0.91	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
83	1.00	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
84	0.94	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE IV

LOOP PRESSURES

Date	Time	Run No.	1A	1D	Average	Reactor Pressure
4/19/60	1850		460	460	455	455
	1905	1	480	470	475	450
	1918	2	500	490	495	480
	1929	3	500	490	495	470
	1940	4	520	500	510	490
	1952	5	460	450	455	440
	2019	6	500	490	495	490
	2037	7	450	440	445	425
	2103	8	475	450	463	450
	2123	9	520	500	510	490
	2152	10	460	450	455	450
	2218	11	510	490	500	480
	2242	12	450	440	445	440
	2310	13	440	420	430	400
4/20/60	2332	14	460	450	455	450
	0025	15	460	450	455	450
	0105	16	460	450	455	450
	0136	17	460	455	457.5	450
	0205	18	485	475	475	480
	0247	19	475	465	470	465
	0344	20	450	425	437.5	465
	0431	21	450	425	437.5	425
	0529	22	475	450	462.5	450
	0706		450	450	450	450
	0845	23	455	440	447.5	440
	0923	24	470	475	472.5	470
	1023	25	490	480	485	480
	1125	26	490	480	485	475
	1250	27	495	480	487.5	480
	1325	28	450	450	450	450
	1400	29	450	450	450	450
	1438	Drove Rods In	450	440	445	430

TABLE V

LOOP FLOWS

Date	Run No.	Time	Loop Flows		
			1A	1C	1D
			lb/hr x 10 ⁶	lb/hr x 10 ⁶	lb/hr x 10 ⁶
4/19/60		1850	5.39	4.0	3.65
	1	1906	5.39	4.0	3.65
	2	1989	5.39	4.0	3.65
	3	1930	5.39	4.0	3.65
	4	1940	5.39	4.0	3.65
	5	1953	5.39	4.0	3.65
	6	2020	5.39	4.0	3.65
	7	2038	5.39	4.0	3.70
	8	2103	5.38	4.0	3.70
	9	2123	5.38	4.0	3.70
	10	2153	5.38	4.0	3.70
	11	2213	5.38	4.0	3.68
	12	2242	5.38	4.0	3.70
	13	2310	5.38	4.0	3.70
4/20/60	14	2310	5.38	4.0	3.70
	15	0025	5.38	4.0	3.70
	16	0105	5.38	4.0	3.70
	17	0136	5.38	4.05	3.70
	18	0205	5.38	4.05	3.70
	19	0247	5.38	4.05	3.70
	20	0344	5.38	4.05	3.70
	21	0431	5.38	4.05	3.70
	22	0529	5.38	4.05	3.70
		0706	5.38	4.05	3.70
	23	0845	5.38	4.02	3.70
	24	0923	5.38	4.02	3.70
	25	1023	00S	4.02	3.70
	26	1125	00S	4.02	3.70
	27	1250	00S	4.02	3.70
	28	1325	00S	4.0	3.70
	29	1400	00S	4.0	3.70
	Drove Rods In	1438	00S	4.0	3.70

TABLE VI
TEMPERATURE COEFFICIENTS

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/26/60	1 *	0952:06	434.9	1267	15.15	12953		15446		1.63	1.272	17.994	10
						22063	1.70	25188	1.63				
						38870	1.76	41274	1.64				
						67264	1.73	67180	1.63				
	2 *	1006:15	436.4	1272	15.15	21501		12574		2.10	0.967	15.442	20
						53811		26616	2.09				
						72625		56451	2.12				
						155289	2.14	118350	2.10				
	3	1024:30	438.8	1282	15.15	13442		12098		2.21	0.688	12.559	30
						30309	2.25	26896	2.22				
						67314	2.22	59875	2.23				
						163871	2.43	129848	2.17				
	4	1040:23	440.2	1285	15.15	16197		279610	2.15	2.08	0.477	9.864	40
						34526	2.13	15515					
						72283	2.09	32614	2.10				
						160909	2.23	68400	2.10				
	5	1108:14	444.3	1309	15.15	339007	2.11	138369	2.02	1.11	0.068	2.020	40
						11364		276438	2.00				
						12883	1.13	10545					
						14378	1.12	11906	1.13				
						15822	1.10	13312	1.12				
						17417	1.10	15237	1.09				
						19205	1.10	16681	1.10				
								18380	1.10				

Temperature Override at 1117:54 Temperature = 445.6 F

* Avg. Ratio - Use only Channel B and Circled readings were not included in the Avg. Ratios.

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE VI (cont'd)

TEMPERATURE COEFFICIENTS

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/26/60	15	2007:06	465.8	1817	15.70			12449		1.30	.683	12.507	10
								16235	1.30				
								21226	1.31				
								28060	1.32				
								36548	1.30				
								47321	1.29				
								61609	1.30				
	16	2018:08	468.2	1815	15.70			79657	1.29	1.17	.409	8.851	10
								11914					
								14159	1.19				
								16694	1.20				
								20090	1.16				
								23427	1.19				
								27899	1.18				
								32948	1.17				
								38633	1.18				
								45461	1.17				
								53032	1.18				
								62550	1.16				
								72821	1.17				
	17	2031:15	470.1	1827	15.70			85387	1.16	1.27	.208	5.271	30
								99419					
								11023					
								14684	1.33				
								19514	1.33				
								25446	1.31				
								31908	1.25				
								40820	1.28				

TABLE VI (cont'd)
TEMPERATURE COEFFICIENTS

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/26/60								51868	1.27				
								64555	1.24				
								80857	1.25				
								99224	1.22				
			Temperature Override at 2049					Temperature = 472.5					
	20	2327:26	495.5	1800	16.50			10876		1.17	.409	8.851	10
								12959	1.19				
								15345	1.18				
								18240	1.19				
								21552	1.18				
								25175	1.17				
								29448	1.17				
								34448	1.17				
								40298	1.17				
								46713	1.16				
								54478	1.17				
								62835	1.15				
								73156	1.16				
	21	2338:54	498.6	1815	16.50			10473		1.07		2.525	20
								11261	1.08				
								11912	1.06				
								13093	1.10				
								13684	1.05				
								14315	1.08				
			Temperature Override at 2344:05					Temperature = 500.0					

TABLE VI (cont'd)
TEMPERATURE COEFFICIENTS

Date	Run No.	Assigned Time	Avg Temp-T _c F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity ρ x 10 ⁻⁴	Base Sec				
						Counts	Ratio	Counts	Ratio								
4/27/60	22	0138:05	504.1	1810	16.85	13154		11993		1.51	1.074	16.400	10				
						19997	1.52	18743	1.56								
						30245	1.51	28272	1.51								
						45628	1.51	42405	1.50								
						67804	1.49	63267	1.49								
	23	0146:31	507.1	1816	16.85			95098	1.50	1.56	.579	11.240	20				
						11711	1.61	10981									
						18906	1.60	17608	1.60								
						30157	1.57	28008	1.59								
						47414	1.55	44020	1.57								
						73316	1.52	68212	1.55								
						111607	1.51	104681	1.53								
						168555		157922	1.51								
	24	0156:11	508.2	1823	16.85	12578		11448		1.28	.214	5.14	30				
						16494	1.31	15528	1.36								
						21522	1.30	20351	1.31								
						27474	1.28	26008	1.28								
						34249	1.25	32339	1.24								
						42826	1.25	40041	1.24								
						Temperature Override at 0204											
						25	2215:12	498.0	1808					16.60	23143		23796
	38768	1.68	38995	1.64													
	64594	1.67	64973	1.67													
	106063	1.64	106675	1.64													
	26	2221:52	499.9	1808	16.60					10976		11613			1.37	.818	13.987
						15259	1.39	15839	1.36								
						21338	1.40	22222	1.40								
						29458	1.38	29840	1.34								
						Temperature = 510.0 F											

31
084
32

TABLE VI (cont'd)
TEMPERATURE COEFFICIENTS

Date	Run No.	Assigned Time	Avg Temp-T _C F	Avg Press psig	Rod Height Inches	Channel A		Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Base Sec
						Counts	Ratio	Counts	Ratio				
4/27/60	27	2232:10	502.4	1810	16.60	40678 55674 75347 14213 18944 25149 33792 44122 57139 73683 79613	1.38 1.37 1.35 1.33 1.33 1.34 1.31 1.30 1.29 1.08	41169 56800 75732 12721 15222 20065 26740 35164 45647 58516 75348	1.38 1.38 1.33 1.19 1.32 1.33 1.32 1.30 1.28 1.29	1.31	.352	7.939	20
	28		505.4	1813	16.60	All Below 10000		10236 10964 11951 12048	 1.07 1.09 1.01	1.05	0.032	0.950	40
Temperature Override at 2245:29 Temperature = 505.8													
4/28/60	29	2258:15	508.9	1807	17.00	16234 27505 46532 77915	 1.69 1.69 1.67	16427 27555 46348 77170	 1.68 1.68 1.67	1.68	1.353	18.608	10
	30	2308:40	511.3	1808	17.00	13327 24053 42047 72788 124903	 1.81 1.75 1.73 1.72	13449 23754 41904 72253 23292	 1.77 1.76 1.72 1.71	1.75	.730	13.040	20
	31	2315:10	512.9	1805	17.00	24713 31343 51411 81854 126927	 1.27 1.64 1.60 1.55	24843 31156 50908 80984 125295	 1.25 1.63 1.59 1.55	1.59	.402	8.744	30

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE VII

PRESSURE COEFFICIENT PORTION OF DLCS 1510109

Date	Run No.	Assigned Time	Temp-Tc F	Press psig	Height Inches	Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Reactivity Corrections to 480 F		Corrected Reactivity $\rho \times 10^{-4}$	Time Base
						Counts	Ratio				ΔT F	Temp. $\Delta \rho \times 10^{-4}$		
4/26/60	6	1514:57	449.9	1230	15.35	10340		1.20	.237	5.859	0.1	- 0.17	5.689	20
						12043	1.16							
						14711	1.22							
						17486	1.19							
						20751	1.19							
						25000	1.20							
						29720	1.19							
						36157	1.22							
						42862	1.19							
						51914	1.21							
						62525	1.20							
						74398	1.19							
						89363	1.20							
						106260	1.19							
						127531	1.20							
						150753	1.18							
						181510	1.20							
	7	1537:05	449.8	1350	15.35	10235		1.57	.392	8.582	0.2	- 0.34	8.242	30
						16042	1.57							
						25211	1.57							
						40062	1.59							
						62412	1.56							
						97733	1.57							
	8	1644:25	449.9	1478	15.35	153859	1.58	1.84	.530	10.590	0.1	- 0.17	10.420	30
						242300	1.58							
						42212								
						23074	1.89							
						42441	1.84							
						77661	1.83							
						142168	1.83							
						256057	1.80							

-33-

034 34

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE VII (cont'd)

PRESSURE COEFFICIENT PORTION OF DLCS 1510109

Date	Run No.	Assigned Time	Temp-Tc F	Press psig	Height Inches	Channel B		Avg Ratio	Start up Rate dec/min	Reactivity $\rho \times 10^{-4}$	Reactivity Corrections to 480 F		Corrected Reactivity $\rho \times 10^{-4}$	Time Base
						Counts	Ratio				ΔT F	Temp. $\Delta \rho \times 10^{-4}$		
4/26/60	9	1710:32	449.9	1547	15.35	17212		2.00	.602	11.528	- 0.1	- 0.17	11.358	30
						34959	2.03							
						69470	1.99							
						138797	2.00							
						271712	1.97							
	10	1738:45	449.7	1655	15.35	14214		1.84	.795	13.754	- 0.3	- 0.51	13.074	20
						26548	1.87							
						49500	1.86							
						90387	1.83							
						164424	1.81							
	11	1802:52	450.2	1743	15.35	10685		1.42	.912	14.920	0.2	+ 0.34	15.260	10
						15030	1.42							
						21815	1.45							
						30899	1.42							
						43421	1.41							
	12	1831:43	449.8	1792	15.35	62030	1.43	1.51	1.074	16.398	- 0.2	- 0.34	16.058	10
						87469	1.41							
						13354								
						20129	1.51							
						30614	1.52							
46410						1.52								
69662						1.50								

NOTE: Channel A Counter operating improperly.

34

034 35

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE VIII

T_c TEMPERATURES

Date	Run No.	Time	Temperatures - Mueller Bridges						Avg. T _c F
			1A Tc		1C Tc		1D Tc		
			Ω	F	Ω	F	Ω	F	
4/26/60	1	0952	46.59	435.0	46.58	434.8	46.51	434.9	434.9
	2	1006	46.68	436.3	46.67	436.5	46.59	436.4	436.4
	3	1025	46.78	438.7	46.77	438.9	46.69	438.8	438.8
	4	1040	46.87	440.4	46.86	440.2	46.78	440.1	440.2
	5	1108	47.08	444.5	47.07	444.3	46.99	444.1	444.3
Temp. Override		1118	47.15	445.8	47.13	445.4	47.06	445.5	445.6
Pressure Coefficient									
		1338	47.34	449.5	47.34	449.5	47.28	449.7	449.6
		1345	47.33	449.3	47.33	449.3	47.25	449.2	449.3
		1501	47.38	450.3	47.36	449.9	47.30	450.1	450.1
	6	1515	47.38	450.3	47.36	449.5	47.29	449.9	449.9
	7	1537	47.36	449.9	47.35	449.7	47.27	449.6	449.8
	8	1644	47.36	449.9	47.368	450.1	47.28	449.7	449.9
	9	1711	47.37	450.1	47.36	449.9	47.284	449.7	449.9
	10	1739	47.354	449.7	47.352	449.7	47.276	449.7	449.7
	11	1802	47.375	450.3	47.38	450.3	47.29	449.9	450.2
	12	1831	47.36	449.9	47.355	449.9	47.28	449.7	449.8
Temperature Coefficient									
	13	1854	47.40	450.7	47.385	450.5	47.32	450.5	450.6
	14	1920	47.74	457.3	47.73	457.1	47.61	456.2	456.7
Temp. Override		1938	47.85	459.5	47.845	459.5	47.76	459.1	459.4
	15	2013	48.19	466.1	48.17	465.7	48.09	465.5	465.8
	16	2019	48.30	468.2	48.30	468.2	48.22	468.1	468.2
	17	2031	48.40	470.2	48.395	470.2	48.31	469.8	470.1
Temp. Override		2049	48.53	472.6	48.52	472.4	48.44	472.4	472.5
	18	2259	49.36	488.8	49.36	488.8	49.27	488.5	488.7
	19	2315	49.57	492.9	49.58	493.1	49.49	492.8	492.9
	20	2327	49.71	495.6	49.70	495.4	49.62	495.4	495.5
	21	2338	49.87	498.7	49.87	498.7	49.78	498.5	498.6
Temp. Override		2344	49.94	500.1	49.93	449.9	49.85	499.9	500.0
4/27/60	22	0138	50.14	504.0	50.15	504.2	50.07	504.1	504.1
	23	0146	50.29	507.0	50.30	507.2	00S	00S	507.1
	24	0154	50.36	508.3	50.37	508.0	00S	00S	508.2
Temp. Override		0204	50.49	510.9	50.50	511.1	00S	00S	510.0
	25	2215	49.828	498.0	49.838	498.2	49.745	497.9	498.0

DUQUESNE LIGHT COMPANY
 POWER STATIONS DEPARTMENT
 SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
 DLCS 1510109
 T-550132

TABLE VIII. (cont'd)

T_c TEMPERATURES

Date	Run No.	Time	Temperatures - Mueller Bridges						Avg. T _c F
			1A T _c Ω	F	1C T _c Ω	F	1D T _c Ω	F	
4/27/60	26	2221	49.928	499.9	49.936	500.1	49.839	499.7	499.9
	27	2230	50.06	502.4	50.065	502.4	49.975	502.4	502.4
	28	2240	50.212	505.4	50.215	505.4	50.13	505.3	505.4
Temp. Override	2246		50.23	505.8	50.235	505.8	50.147	505.7	505.8
	29	2258	50.389	508.9	50.393	508.9	50.307	508.9	508.9
	30	2308	50.508	511.3	50.52	511.5	50.427	511.2	511.3
	31	2314	50.585	512.9	50.60	513.1	50.505	512.8	512.9

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE IX

CONTROL ROD POSITION (INCHES) - AUX. ROD CONTROL PANEL

Run	1	2	3	4	5	6	7	8	9
Time	0951	1004	1021	1036	1056	1505	1531	1640	1706
Rod No.									
11	15.22	-----	-----	-----	-----	15.41	-----	-----	-----
12	15.23	-----	-----	-----	-----	15.42	-----	-----	-----
13	15.16	-----	-----	-----	-----	15.36	-----	-----	-----
14	15.14	-----	-----	-----	-----	15.33	-----	-----	-----
21	15.06	-----	-----	15.07	15.06	15.27	-----	-----	-----
22	15.11	-----	-----	15.12	15.11	15.32	-----	-----	-----
23	15.05	-----	-----	15.06	15.05	15.25	-----	-----	-----
24	15.16	-----	-----	15.17	15.16	15.37	-----	-----	-----
31	15.18	-----	-----	-----	-----	15.38	-----	-----	-----
32	15.13	-----	-----	-----	-----	15.33	-----	-----	-----
33	15.16	-----	-----	-----	-----	15.35	-----	-----	-----
34	15.23	-----	-----	-----	-----	15.42	-----	-----	-----
41	1.02	-----	-----	-----	-----	-----	-----	-----	-----
42	0.96	-----	-----	-----	-----	-----	-----	-----	-----
43	1.07	-----	-----	-----	-----	-----	-----	-----	-----
44	0.96	-----	-----	-----	-----	-----	-----	-----	-----
51	15.10	-----	-----	-----	-----	15.28	-----	-----	-----
52	15.09	-----	-----	-----	-----	15.27	-----	-----	-----
53	15.12	-----	-----	-----	-----	15.35	-----	-----	-----
54	15.23	-----	-----	-----	-----	15.41	-----	-----	-----
61	15.18	-----	-----	-----	-----	15.34	-----	-----	-----
62	15.21	-----	-----	-----	-----	15.36	-----	-----	-----
63	15.16	-----	-----	-----	-----	15.32	-----	-----	-----
64	15.24	-----	-----	-----	-----	15.40	-----	-----	-----
71	15.13	-----	-----	-----	-----	15.35	-----	-----	-----
72	15.09	-----	-----	-----	-----	15.28	-----	-----	-----
73	15.16	-----	-----	-----	-----	15.37	-----	-----	-----
74	15.19	-----	-----	-----	-----	15.40	-----	-----	-----
81	1.04	-----	-----	-----	-----	-----	-----	-----	-----
82	-0.99	-----	-----	-----	-----	-----	-----	-----	-----
83	1.05	-----	-----	-----	-----	-----	-----	-----	-----
84	0.99	-----	-----	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
 POWER STATIONS DEPARTMENT
 SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
 DLCS 1510109
 T-550132

TABLE IX (cont'd)

CONTROL ROD POSITION (INCHES) - AUX. ROD CONTROL PANEL

Run	10	11	12	13	14	Temp. Override	15	16	17
Time	1738	1803	1830	1854	1924	1938	2005	2017	2030
Rod No.									
11	15.41	-----	-----	-----	-----	-----	15.95	-----	-----
12	15.42	-----	-----	-----	-----	-----	15.76	-----	-----
13	15.36	-----	-----	-----	-----	-----	15.70	-----	-----
14	15.33	-----	-----	-----	-----	-----	15.67	-----	-----
21	15.27	-----	-----	-----	-----	-----	15.62	-----	-----
22	15.32	-----	-----	-----	-----	-----	15.67	15.68	-----
23	15.26	15.25	-----	-----	-----	-----	15.60	15.61	-----
24	15.38	15.37	-----	-----	-----	-----	15.71	15.72	-----
31	15.38	-----	-----	-----	-----	-----	15.72	-----	-----
32	15.33	-----	-----	-----	-----	-----	15.61	-----	-----
33	15.35	-----	-----	-----	-----	-----	15.69	-----	-----
34	15.42	-----	-----	-----	-----	-----	15.75	-----	-----
41	1.02	-----	-----	-----	-----	-----	-----	-----	-----
42	0.96	-----	-----	-----	-----	-----	-----	-----	-----
43	1.07	-----	-----	-----	-----	-----	-----	-----	-----
44	0.96	-----	-----	-----	-----	-----	-----	-----	-----
51	15.28	-----	-----	-----	-----	-----	15.65	-----	-----
52	15.27	-----	-----	-----	-----	-----	15.64	-----	-----
53	15.35	-----	-----	-----	-----	-----	15.71	-----	-----
54	15.41	-----	-----	-----	-----	-----	15.77	-----	-----
61	15.34	-----	-----	-----	-----	-----	15.68	-----	-----
62	15.36	-----	-----	-----	-----	-----	15.71	-----	-----
63	15.32	-----	-----	-----	-----	-----	15.66	-----	-----
64	15.40	-----	-----	-----	-----	-----	15.74	-----	-----
71	15.35	-----	-----	-----	-----	-----	15.68	-----	-----
72	15.28	-----	-----	-----	-----	-----	15.62	-----	-----
73	15.37	-----	-----	-----	-----	-----	15.71	-----	-----
74	15.40	-----	-----	-----	-----	-----	15.73	-----	-----
81	1.04	-----	-----	-----	-----	-----	-----	-----	-----
82	0.99	-----	-----	-----	-----	-----	-----	-----	-----
83	1.05	-----	-----	-----	-----	-----	-----	-----	-----
84	0.99	-----	-----	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE IX (cont'd)

CONTROL ROD POSITION (INCHES) - AUX. ROD CONTROL PANEL

Run	Temp. Override	18	19	20	21	22	23
Time	2045	2259	2315	2325	2334	0140	0145
Rod No.							
11	15.95	16.25	16.50	-----	-----	16.84	-----
12	15.76	16.26	16.51	-----	-----	16.84	-----
13	15.70	16.20	16.45	-----	-----	16.78	-----
14	15.67	16.70	16.47	-----	-----	16.76	-----
21	15.62	16.25	16.50	-----	-----	16.90	-----
22	15.68	16.18	16.43	-----	-----	16.81	-----
23	15.60	16.23	16.48	-----	-----	16.88	-----
24	15.72	16.22	16.48	16.47	-----	16.87	-----
31	15.72	16.21	16.47	-----	-----	16.84	-----
32	15.61	16.17	16.42	-----	-----	16.79	-----
33	15.69	16.19	16.44	-----	-----	16.82	-----
34	15.75	15.26	16.50	-----	-----	16.88	-----
41	1.02	-----	-----	-----	-----	-----	-----
42	0.96	-----	-----	-----	-----	-----	-----
43	1.07	-----	-----	-----	-----	-----	-----
44	0.96	-----	-----	-----	-----	-----	-----
51	15.65	16.15	16.39	-----	-----	16.80	-----
52	15.64	16.13	16.37	-----	-----	16.78	-----
53	15.71	16.20	16.45	-----	-----	16.86	-----
54	15.77	16.27	16.51	-----	-----	16.92	-----
61	15.68	16.18	16.43	-----	-----	16.75	-----
62	15.71	16.21	16.46	-----	-----	16.78	-----
63	15.66	16.16	16.41	-----	-----	16.74	-----
64	15.74	16.24	16.49	-----	-----	16.81	-----
71	15.68	16.19	16.43	-----	-----	16.93	-----
72	15.62	16.13	16.38	-----	-----	16.88	-----
73	15.71	16.21	16.46	-----	-----	16.96	-----
74	15.73	16.24	16.48	-----	-----	16.99	-----
81	1.04	-----	-----	-----	-----	-----	-----
82	0.99	-----	-----	-----	-----	-----	-----
83	1.05	-----	-----	-----	-----	-----	-----
84	0.99	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE IX (cont'd)

CONTROL ROD POSITION (INCHES) - AUX. ROD CONTROL PANEL

Run	24	25	26	27	28	29	30	31
Time	0156	2215	2221	2230	2240	2258	2308	2314
Rod No.								
11	16.84	16.60	-----	-----	-----	17.00	-----	-----
12	16.84	16.60	-----	-----	-----	17.02	-----	-----
13	16.78	16.66	-----	-----	-----	17.08	-----	-----
14	16.76	16.51	-----	-----	-----	16.92	-----	-----
21	16.90	16.64	-----	-----	16.63	17.02	-----	-----
22	16.81	16.56	-----	-----	16.55	16.94	-----	-----
23	16.88	16.62	-----	16.61	-----	17.00	-----	-----
24	16.87	16.61	-----	-----	16.60	17.00	-----	-----
31	16.84	16.63	-----	-----	-----	17.02	-----	-----
32	16.79	16.57	-----	-----	-----	17.98	-----	-----
33	16.82	16.59	-----	-----	-----	16.99	-----	-----
34	16.88	16.65	-----	-----	-----	17.06	-----	-----
41	1.02	0.95	-----	-----	-----	-----	-----	-----
42	0.96	1.02	-----	-----	-----	-----	-----	-----
43	1.07	1.00	-----	-----	-----	-----	-----	-----
44	0.96	1.01	-----	-----	-----	-----	-----	-----
51	16.80	16.60	-----	-----	-----	17.00	-----	-----
52	16.78	16.58	-----	-----	-----	16.98	-----	-----
53	16.86	16.61	-----	-----	-----	17.06	-----	-----
54	16.92	16.60	-----	-----	-----	17.00	-----	-----
61	16.75	16.58	-----	-----	-----	16.97	-----	-----
62	16.78	16.61	-----	-----	-----	17.00	-----	-----
63	16.74	16.57	-----	-----	-----	16.96	-----	-----
64	16.81	16.64	-----	-----	-----	17.04	-----	-----
71	16.93	16.55	-----	-----	-----	16.96	-----	-----
72	16.88	16.62	-----	-----	-----	17.03	-----	-----
73	16.96	16.58	-----	-----	-----	16.98	-----	-----
74	16.94	16.60	-----	-----	-----	17.02	-----	-----
81	1.04	1.00	-----	-----	-----	-----	-----	-----
82	0.99	0.94	-----	-----	-----	-----	-----	-----
83	1.05	1.01	-----	-----	-----	-----	-----	-----
84	0.99	0.96	-----	-----	-----	-----	-----	-----

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE X

LOOP PRESSURES

Date	Time	Run No.	1A	1C	1D	Average	Reactor Pressure
4/26/60	0945		1260	1260	1280	1266.67	1240
	0950	1	1260	1260	1280	1266.67	1230
	1004	2	1275	1260	1280	1271.67	1240
	1021	3	1275	1280	1290	1281.67	1240
	1035	4	1275	1280	1300	1285.00	1250
	1056	5	1300	1300	1320	1308.67	1270
	Temp. Override						
	1118		1240	1240	1270	1230.0	1200
	1505	6	1240	1240	1270	1230.0	1210
	1530	7	1350	1350	1350	1350.0	1310
	1640	8	1475	1460	1500	1478.0	1450
	1710	9	1540	1525	1575	1546.6	1500
Temp. Override	1737	10	1650	1640	1675	1655	1600
	1802	11	1730	1730	1770	1743	1710
	1831	12	1780	1780	1815	1792	1750
	End of Press. Coef.						
	Begin Temp. Coef.						
	1853	13	1800	1805	1835	1813	1775
	1912	14	1800	1790	1830	1807	1770
	Temp. Override						
	1931		1790	1800	1825	1805	1760
	2004	15	1800	1810	1840	1817	1775
	2015	16	1795	1800	1850	1815	1760
	2027	17	1810	1825	1845	1827	1780
Temp. Override	2043		1785	1790	1820	1793	1760
	2255	18	1805	1805	1840	1817	1775
	2314	19	1800	1795	1840	1812	1765
	2327	20	1790	1785	1825	1800	1760
	2338	21	1805	1810	1830	1815	1775
	Temp. Override						
	2344		1805	1810	1830	1815	1775
	4/27/60						
	0136	22	1800	1800	1830	1810	1775
	0145	23	1805	1805	1840	1816.6	1785
	0153	24	1810	1810	1850	1823.3	1800
	Temp. Override						
	0204		1810	1810	1850	1823.3	1800

DUQUESNE LIGHT COMPANY
 POWER STATIONS DEPARTMENT
 SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
 DLCS 1510109
 T-550132

TABLE X (cont'd)

LOOP PRESSURES

Date	Time	Run No.	1A	1C	1D	Average	Reactor Pressure
4/27/60	2215	25	1800	1800	1825	1808	1785
	2221	26	1800	1800	1825	1808	1780
	2230	27	1800	1800	1830	1810	1780
	2240	28	1800	1805	1835	1813	1780
	2258	29	1795	1795	1830	1807	1780
	2308	30	1800	1795	1830	1808	1780
	2314	31	1795	1795	1825	1805	1775

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE XI
LOOP FLOWS

Date	Time	Run No.	1C	1D
4/26/60	0945		7.73	6.8
	0950	1	7.72	6.5
	1004	2	7.72	6.6
	1021	3	7.72	6.7
	1035	4	7.72	6.7
	1056	5	7.72	6.6
	Temp. Override			
	1118		7.70	6.4
	1505	6	7.70	7.05
	1530	7	7.70	6.60
	1640	8	7.70	7.09
	1708	9	7.70	6.70
	1736	10	7.70	7.05
	1802	11	7.70	7.09
	1831	12	7.70	7.09
	End of Press. Coef. Begin Temp. Coef.			
	1853	13	7.71	7.09
	1912	14	7.70	7.09
	Temp. Override			
	1931		7.68	7.07
	2004	15	7.68	7.07
	2015	16	7.65	7.02
	2027	17	7.63	7.03
	Temp. Override			
	2043		7.62	7.03
	2255	18	7.59	7.00
	2314	19	7.56	6.98
	2727	20	7.54	6.95
	2338	21	7.53	6.91
	Temp. Override			
	2344		7.52	6.90
	4/27/60			
	0137	22	7.50	6.90
	0145	23	7.50	6.90
	0153	24	7.50	6.90
	Temp. Override			
	0204		7.50	6.90

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLGS-1510109
T-550132

TABLE XI (cont'd)

LOOP FLOWS

Date	Time	Run No.	1C	1D
4/27/60	2215	25	7.52	6.90
	2221	26	7.51	6.90
	2230	27	7.51	6.90
	2240	28	7.50	6.89
	2258	29	7.47	6.87
	2308	30	7.48	6.87
	2314	31	7.48	6.86

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE XII

T_c CALIBRATING THERMOMETERS*

Date	Time	1A ohms	F	1C ohms	F	1D ohms	F	Avg. F
4/25/60	2000	38.58	282.4	38.57	282.3	38.50	281.7	282.1
	2030	39.95	308.3	39.93	308.0	39.89	308.0	308.1
	2109	41.78	343.1	41.77	343.0	41.74	343.1	343.1
	2130	41.89	345.1	41.89	345.1	41.81	344.4	344.7
	2200	41.73	342.1	41.73	342.2	41.66	341.6	341.9
	2230	41.60	339.7	41.60	339.8	41.52	338.9	339.5
	2300	41.46	337.0	41.46	337.1	41.38	336.3	336.8
	2330	43.64	378.6	43.62	378.4	43.58	378.3	378.4
	2400	46.13	426.5	46.10	426.0	45.05	425.9	426.1
	0030	46.27	429.3	46.28	429.5	46.21	428.9	429.2
	0100	46.32	430.3	46.33	430.5	46.25	429.3	430.0

*Data taken during reactor heat up.

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE XIII

CONTROL ROD POSITIONS (INCHES)*

DATE: 4/25/60 and 4/26/60

Time	2000	2030	2100	2130	2200	2230	2300	2330	2400	0030	0100
Rod No.											
11	19.65	19.65	20.59	21.03	20.61	20.61	20.61	22.60	24.61	24.60	24.60
12	19.67	19.67	20.60	21.04	20.61	20.61	20.61	22.60	24.62	24.61	24.61
13	19.73	19.73	20.66	21.10	20.69	20.69	20.69	22.66	24.68	24.68	24.68
14	19.71	19.71	20.68	21.00	20.66	20.66	20.66	22.68	24.66	24.64	24.64
31	19.85	19.85	20.80	20.80	20.80	20.80	20.80	22.80	24.80	24.80	24.80
32	19.80	19.80	20.75	20.75	20.75	20.75	20.75	22.75	24.75	24.75	24.75
33	19.70	19.70	20.65	20.65	20.65	20.65	20.65	22.64	24.64	24.64	24.64
34	19.75	19.75	20.71	20.71	20.71	20.71	20.71	22.71	24.71	24.71	24.71
51	20.27	20.27	21.83	21.83	21.83	21.83	21.83	23.23	24.75	24.97	25.32
52	20.26	20.26	21.81	21.81	21.81	21.81	21.81	23.22	24.81	24.95	25.31
53	20.34	20.34	21.88	21.88	21.88	21.88	21.88	23.30	24.88	25.03	25.37
54	20.28	20.28	21.82	21.82	21.82	21.82	21.82	23.24	24.82	24.97	25.31
71	18.89	18.89	20.89	20.89	20.89	20.55	20.55	21.93	23.96	23.95	23.95
72	18.82	18.82	20.83	20.83	20.83	20.49	20.49	21.87	23.91	23.89	23.89
73	18.79	18.79	20.79	20.79	20.79	20.44	20.44	21.83	23.86	23.85	23.85
74	18.94	18.94	20.94	20.94	20.94	20.60	20.60	21.98	24.02	24.00	24.00

*Data taken during reactor heat up.

DUQUESNE LIGHT COMPANY
POWER STATIONS DEPARTMENT
SHIPPINGPORT ATOMIC POWER STATION

MEASUREMENT OF COEFFICIENTS OF REACTIVITY
DLCS 1510109
T-550132

TABLE XIV

INTERMEDIATE RANGE NUCLEAR INSTRUMENTATION *

DATE: 4/24/60

Time	Ch. A	Ch. B	Ch. C	Ch. D
2000	6×10^{-9}	9×10^{-8}	7×10^{-9}	5×10^{-9}
2030	1×10^{-6}	4.75×10^{-4}	2.5×10^{-6}	4.8×10^{-6}
2100	5.7×10^{-5}	3×10^{-4}	5.8×10^{-5}	5.9×10^{-5}
2130	7×10^{-8}	1×10^{-8}	7×10^{-8}	7.5×10^{-8}
2200	7.5×10^{-8}	1×10^{-8}	7×10^{-8}	8×10^{-8}
2230	7.5×10^{-8}	1×10^{-8}	7.5×10^{-8}	8×10^{-8}
2300	7.5×10^{-8}	1×10^{-8}	7.5×10^{-8}	8×10^{-8}
2330	7×10^{-5}	2×10^{-4}	8×10^{-5}	8×10^{-5}
2400	4×10^{-7}	5×10^{-6}	5×10^{-2}	2×10^{-7}
0030	6×10^{-7}	1×10^{-5}	4.5×10^{-7}	4×10^{-7}
0100	5×10^{-7}	1×10^{-5}	4.5×10^{-7}	4×10^{-7}

*Data taken during reactor heat up.

TEST RESULTS DLG 1510109

T-550132

MEASUREMENT OF COEFFICIENTS OF REACTIVITY, (cont'd)

Results Prepared By John Symantek per Rk Date 7-8-60

Results Reviewed By Roger J. Lawrence Date 7-8-60

Approved (Duquesne Light Company) Charles E. Jones Date 9-22-60