DUKE POWER COMPANY

McGUIRE NUCLEAR STATION

UNIT 2 CYCLE 8

STARTUP REPORT

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1.0 Introduction

Core loading for McGuire Unit 2 Cycle 8 was started on February 19, 1992, and was completed February 22. The core for McGuire 2 Cycle 8 consists of 121 Westinghouse optimized fuel assemblies and 72 Babcock & Wilcox Mark-BW fuel assemblies. To control power peaking and maximize cycle length, 64 Burnable Absorber inserts are used. Figure 1 gives the Unit 2 Cycle 8 core loading pattern.

Criticality, Zero Power Physics Testing (ZPPT) and Power Escalation Testing (PET) began March 15, 1992. The unit reached 100% power on March 25, 1992.

Figure 1

McGuire Nuclear Station
Unit 2 Cycle 8

Core Loading Pattern

ASM#
Ins#

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
A					U69 201KT	V63 124	U30 119	V75 56	U72 220KT	V09 85	U46 11[illegible]					A
B			U53 229KT	U39 R134	V50 B6NY	U75 R115	V71 B6PZ	U08 R154	V42 B6R1	U44 R151	V04 B6P0	U37 R153	U15 218KT			B
C		U43 94	U65 73	V52 B6P6	U10 R146	V14 B6RR	U09 R109	U74 105	U32 R148	V10 B6RU	U12 R155	V25 B6PA	U11 96	U55 55		C
D		U21 R160	V48 B6P4	T03 R137	V59 B6R9	T10 315KT	V62 B6RC	T24 R113	V54 B6RE	T14 68	V20 B6RG	T05 R103	V34 B6PA	U03 R106		D
E	U35 83	V03 B6NW	U62 R143	V01 B6R7	T37 334KT	U06 103	T68 81	V22 B6PM	T01 69	U70 51	T38 127	V68 B6RL	U20 R144	V41 B6P2	U13 228KT	E
F	V30 108	U01 R1[illegible]2	V46 B6RN	T27 126	U19 207KT	T57 R145	V60 B6PH	T35 [illegible]60	V16 B6PR	T28 R124	U59 59	T65 75	V43 B6RW	U24 R107	V21 53	F
G	U27 50	V55 B6PX	U48 R17	V32 B6R6	T13 122	V57 B6PX	T64 205KT	V08 B6PL	T72 45	V28 B6PU	T25 206KT	V66 B6RK	U18 R162	V58 B6R3	U51 133	G
H	V73 120	U04 R1[illegible]3	U58 OS88	T46 R111	V61 B6PC	T06 R118	V38 B6PG	T19 R159	V36 B6PP	T21 R116	V65 B6PV	T47 R120	U31 OS89	U52 R63	V76 44	H
J	U68 215KT	V53 B6PW	U50 R141	V29 B6R5	T40 331KT	V45 B6PD	T09 147KT	V70 B6PK	T63 57	V17 B6PT	T43 222KT	V69 B6RJ	U05 R139	V05 B6R2	U64 71	J
K	V06 114	U33 R119	V13 B6RM	T6[illegible] 84	U40 95	T45 R108	V56 B6PF	T41 R12[illegible]	V37 B6PN	T17 R135	U60 88	T04 208KT	V47 B6RV	U26 R110	V33 211KT	K
L	U61 270KT	V35 B6NV	U76 R105	V44 B6R4	T36 58	U36 91	T26 226KT	V07 B6PJ	T44 46	U25 139	T60 312KT	V26 B6[illegible]	U02 R121	V18 B6P1	U41 219KT	L
M		U34 R136	V67 B6P3	T55 R131	V15 B6R8	T39 72	V31 B6RA	T48 R142	V23 B6RD	T49 313KT	V51 B6RF	T18 R125	V24 B6P9	U57 R150		M
N		U42 216KT	U22 125	V40 B6P5	U29 R138	V49 B6RP	U17 R129	U38 227KT	U14 R126	V39 B6RT	U66 R112	V02 B6P7	U56 221KT	U71 60		N
P			U73 121	U07 R140	V27 B6NX	U63 R102	V12 B6PY	U23 R61	V11 B6RO	U16 R128	V19 B6NZ	U67 R152	U47 204KT			P
R					U45 52	V72 225KT	U54 212KT	V74 100	U49 80	V64 67	U28 209KT					R
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

1.1 Prestartup NIS Realignment Following Refueling - PT/0/A/4600/78

This procedure was performed on March 2-4, 1992.

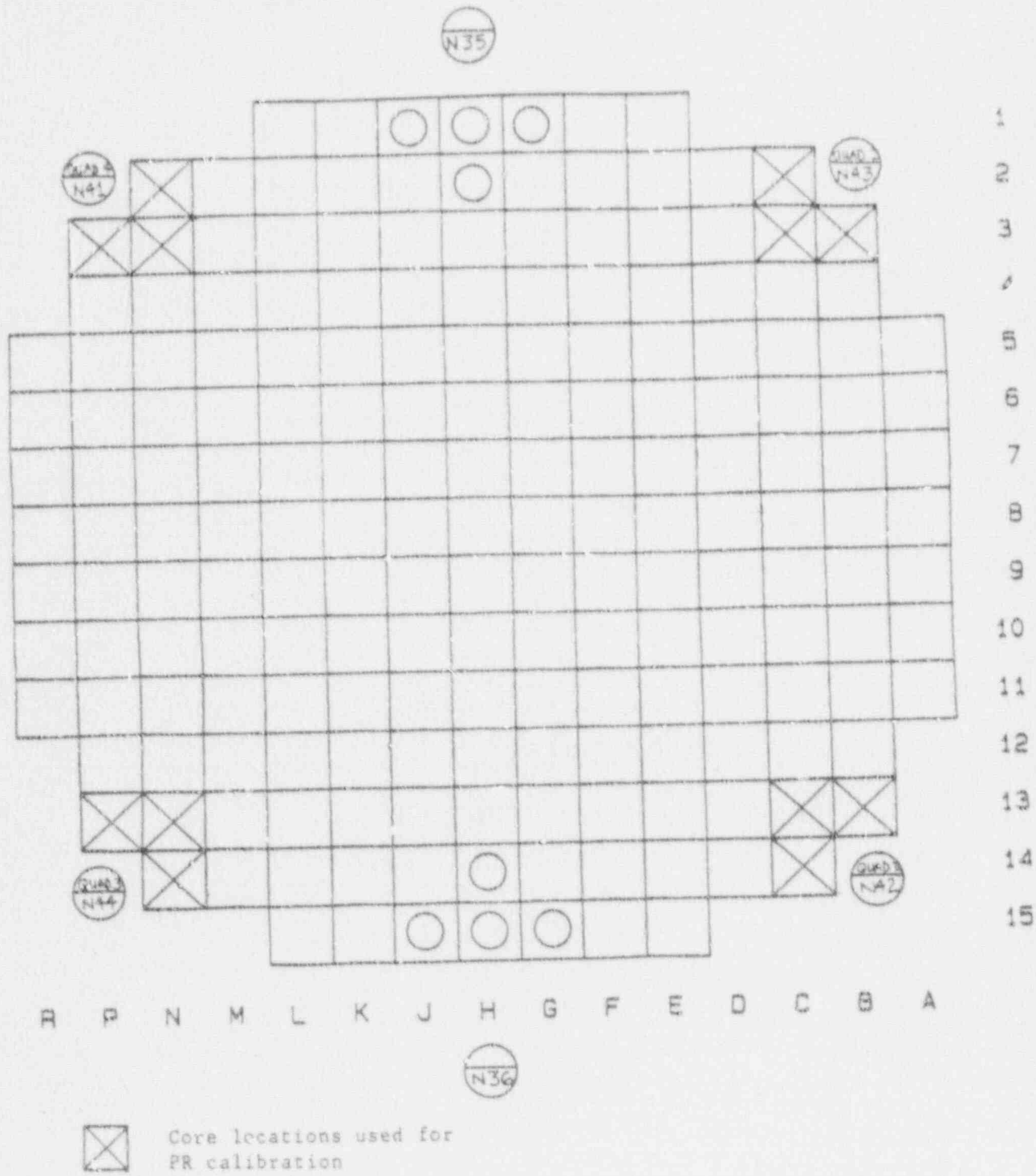
This test was used to calculate preliminary calibration data for the intermediate range (IR) and power range (PR) detectors following refueling.

The set of Cycle 8 preliminary calibration data was determined by taking the End of Cycle 7 (EOC7) calibration data and adjusting it by a weighted average of the ratio of the sum of the predicted assembly powers for the Cycle 8 loading to the sum of the measured assembly powers from the last Cycle 7 Incore/Excore calibration. The core locations used to calculate the ratio of the predicted Beginning of Cycle 8 (BOC8) assembly powers to the measured EOC7 values are shown in Figure 2.

The average predicted BOC8-to-EOC7 IR ratio was ~1.05; the average predicted BOC8-to-EOC7 PR ratio was ~0.91. Based on these results, the IR and PR currents were adjusted prior to Cycle 8 Initial Criticality.

Figure 2

Assemblies to Use for Calculating
IR and PR Calibration Setpoints



☒ Core locations used for PR calibration

◯ Core locations used for IR calibration

2.0 Criticality Following a Change in Core Nuclear Characteristics - PT/0/A/4150/28

On March 15, 1992, boron samples were taken in preparation for the approach to criticality. These samples indicated reactor coolant boron to be 1911 ppm. Since it was desired to achieve criticality with either:

(a) ~500 pcm of Control Bank D inserted, <u>OR</u>

(b) the lowest allowable boron concentration while maintaining 1.0% Shutdown Margin.

a target value of 1646 ppm was chosen for reactor coolant boron concentration. This was based upon a predicted HZP, ARO, no Xenon, equilibrium samarium critical boron concentration at BOC of 1696 ppm minus 50 ppm. This met the requirements of (b) above, which was 1640 ppm (1% shutdown margin at 557°F plus 100 ppm conservatism). Calculations using the unit Data Book (OP/2/A/6100/22) indicated a volume of 9112 gallons of demineralized water should be added to the system to dilute from 1911 ppm to 1646 ppm. On March 15, 1992, this dilution of the Reactor Coolant System was started. The dilution was secured after 9112 gallons of demineralized water had been added to the system. After adequate system mixing, Chemistry samples indicated Reactor Coolant System boron was 1622 ppm.

On March 15, 1992, rod withdrawal commenced starting the Shutdown Bank A. As rods were withdrawn, both source range detectors were observed and rod motion was stopped each time either flux level doubled or any control rod bank was fully withdrawn. At these points a set of counts was taken on each source range detector and Inverse Count Rate Ratio (ICRR) was plotted to monitor the approach to criticality. The unit achieved criticality at 1615 hours on March 15, 1992, with Control Bank D at 61 steps withdrawn. The predicted critical position per OP/0/A/6100/06, Reactivity Balance Calculation was 71 steps withdrawn on Control Bank D. This represented a reactivity difference of 63 pcm based on the predicted HZP, No Xenon Integral Rod Worths.

3.0 **Zero Power Physics Testing - (ZPPT)**

Zero Power Physics Testing for McGuire 2 Cycle 8 started March 15, 1992, and was completed March 17, 1992. The output of Power Range Detector N42 was used as input to the reactivity computer for Zero Power Physics Testing. All acceptance criteria for ZPPT were met.

A minimum of one decade of overlap between the source range and the intermediate range detectors was verified on March 15, 1992, via the Control Board indication, the NIS panel, and the Operator Aid Computer (OAC). The results shown on table 1 reflect the data from the OAC.

The point of adding nuclear heat was determined March 15, 1992. This was done by establishing a slow positive startup rate and observing a change in plant parameters such as an increase in the reactivity trace and an increase in pressurizer level. The test was performed twice to establish repeatability of the data. Table 2 gives the results of the two trials which were used to determine an average nuclear heat reading.

Nuclear heat was determined to be at an average flux level of 4.10×10^{-7} amps on the reactivity computer picoammeter (N42) and 2.606×10^{-7} amps on Intermediate Range Detector N35 and 3.032×10^{-7} amps on Intermediate Range Detector N36. From these results the test band for ZPPT was determined to be 10^{-8} to 10^{-7} amps on the reactivity computer.

On March 15, 1992, an on line checkout of the reactivity computer was performed. This was done by withdrawing Control Bank D until a positive reactivity insertion of ~+25 pcm was indicated on the reactivity computer. The time for the flux level to double was measured and from this doubling time (DT), the reactor period was calculated (period = DT/0.693). Using the reactor period, the amount of reactivity was determined using the predicted data. This reactivity was compared to the reactivity computer indication. The test was repeated for a reactivity insertion of ~+40 pcm. An on-line negative reactivity checkout on the reactivity computer was also performed. This was done by inserting Control Bank D until a negative reactivity change of ~-40 pcm was indicated on the reactivity computer. The time for the flux level to halve was measured and from this halving time (HT), the reactor period was calculated (period = HT/0.693). Using the reactor period, the amount of reactivity was determined using predicted data. This reactivity was compared to the reactivity computer indication. The test as repeated for a reactivity change of ~-25 pcm. The final results met all acceptance criteria and are given in Table 3.

An electronics only negative reactivity insertion test was also completed satisfactorily as part of PT/0/B/4600/55, Reactivity Computer Periodic Test.

TABLE 2

Overlap Data
on March 15, 1992
via the OAC

	Source Range cps		Intermediate Range amps	
	N31	N32	N35	N36
When IR on scale:	700	700	1.1×10^{-11}	1.2×10^{-11}
After 1 decade increase on IR:	15000	15000	1.1×10^{-10}	1.5×10^{-10}
When SR blocked:	16000	16000	1.6×10^{-10}	1.6×10^{-10}

TABLE 2

Nuclear Heat

	Reactivity Computer	Intermediate Range	
	N42	N35	N36
Trial 1	2.60×10^{-7}	1.697×10^{-7}	1.967×10^{-7}
Trial 2	5.60×10^{-7}	3.514×10^{-7}	4.097×10^{-7}
Average	4.10×10^{-7} amps	2.606×10^{-7} amps	3.032×10^{-7} amps

Test Band: 10^{-8} to 10^{-7} amps on N42

TABLE 3

Reactivity Computer Checkout

Results on March 15, 19[illegible]

Initial Flux Level [illegible]) Reactivity Compu[illegible]	Period (Seconds)	Doubling or Halving Time (Seconds)	Reactivity Computer ($\Delta\rho$) (pcm)	Reactivity from DT or HT ($\Delta\rho_c$) (pcm)	+ $\Delta\rho$ % Error
3.6×10^{-8}	189.53	131.3	33.46	34.16	2.05
4.5×10^{-8}	113.89	78.93	51.36	52.21	1.62
3.99×10^{-8}	-270.30	187.32	-33.85	-32.68	3.58
4.00×10^{-8}	-311.79	216.07	-28.44	-27.68	2.76

+ $\left|\frac{\Delta\rho - \Delta\rho_c}{\Delta\rho_c}\right| \times 100$

3.1 Boron Endpoint Mea(urement - PT/0/A/4150/10

This test was performed March 16, 1992. Three sets of data were obtained. In the first set, Control Bank D was initially at 212 steps withdrawn, the Reactor Coolant System boron concentration was 1695 ppm and the Pressurizer boron concentration as 1730 ppm.

Control Bank D was pulled to the All Rods Out (ARO) Configuration and the resulting reactivity change was converted to equivalent boron using the predicted Differential Boron Worth. Control Bank D was then reinserted to the just critical condition and the test was performed two more times.

The results of these reactivity changes were each added to the initial Reactor Coolant System boron concentration to give the ARO Boron Endpoint. The values were averaged to give the final result of 1696 ppm. This value met the acceptance criterion of the Hot Zero Power (HZP) ARO Critical Boron concentration of 1696 ±50 ppm.

3.2 Isothermal Temperature Coefficient Measurement - PT/0/A/4150/12

This test was performed on March 16, 1992. The test measures Isothermal Temperature Coefficient (ITC) by plotting Reactivity versus Average Reactor Coolant System Temperature. The Moderator Temperature Coefficient (MTC) is found using the following relationship:

MTC (pcm/°F) = ITC - Doppler Temperature Coefficient

The acceptance criterion on the ARO ITC was 1.03 ±2.0 pcm/°F. The predicted Doppler Temperature Coefficient was -1.44 pcm/°F.

The Reactor Coolant System boron concentration was 1695 ppm at the start of the test. A heatup/cooldown was performed while keeping rod position and boron concentration constant to determine reactivity change versus temperature. The heatup/cooldown was performed a second time because equipment problems rendered the data from the first cooldown/heatup invalid. The results are shown in Figures 3 and 4. The average ARO ITC was found to be -0.1 pcm/°F. This fell within the acceptance criterion band. This gave an ARO MTC of +1.34 pcm/°F which was within acceptable Technical Specification limits.

Following the completion of this test, PT/0/A/4150/31, Determination of Rod Withdrawal Limits to Ensure Moderator Temperature Coefficient Within Limits of Technical Specifications was performed. The results of this test indicated there were no rod withdrawal limits needed for Unit 2 Cycle 8.

Figure 3

ITC Cooldown Data

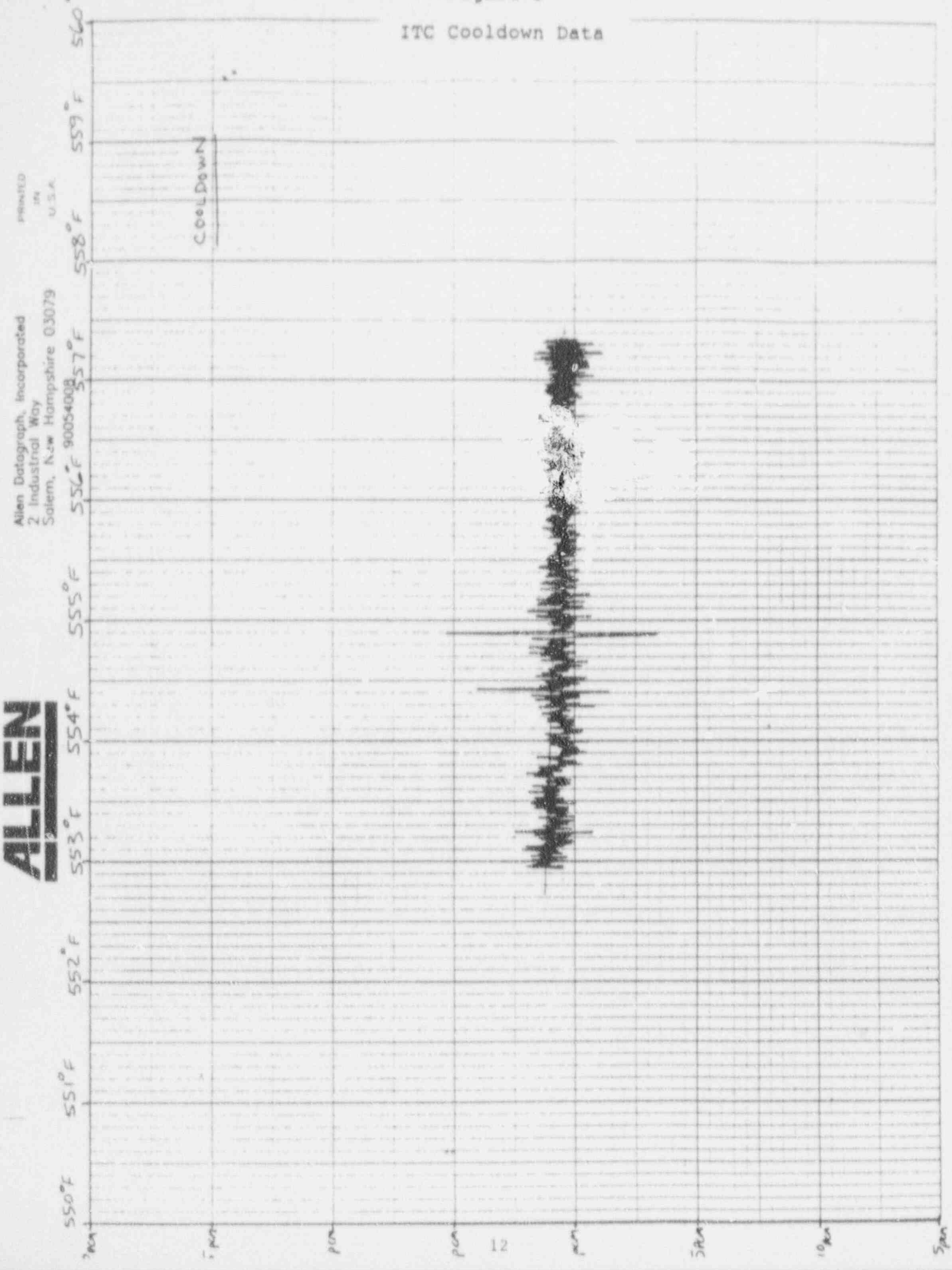
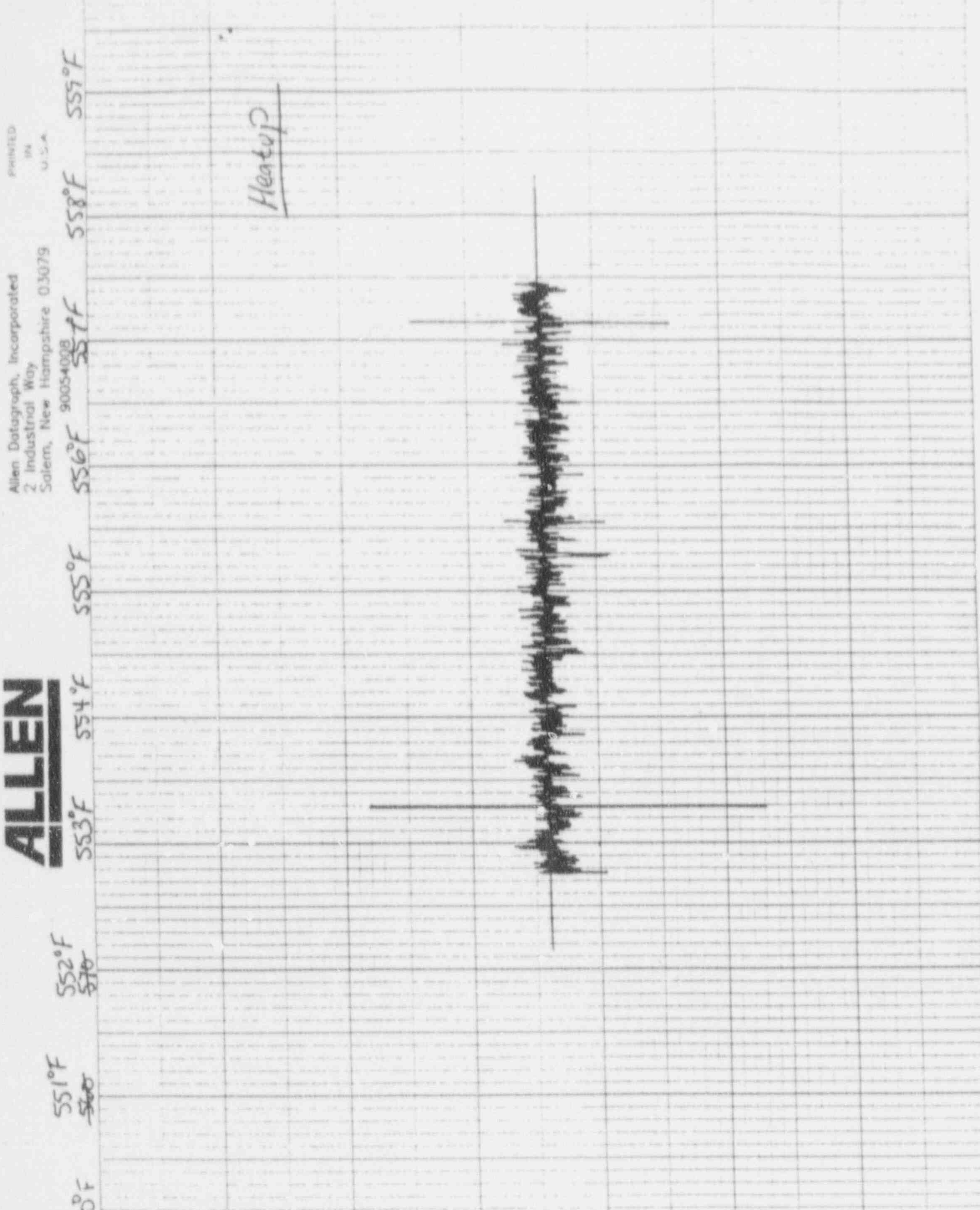


Figure 4

ITC Heatup Data

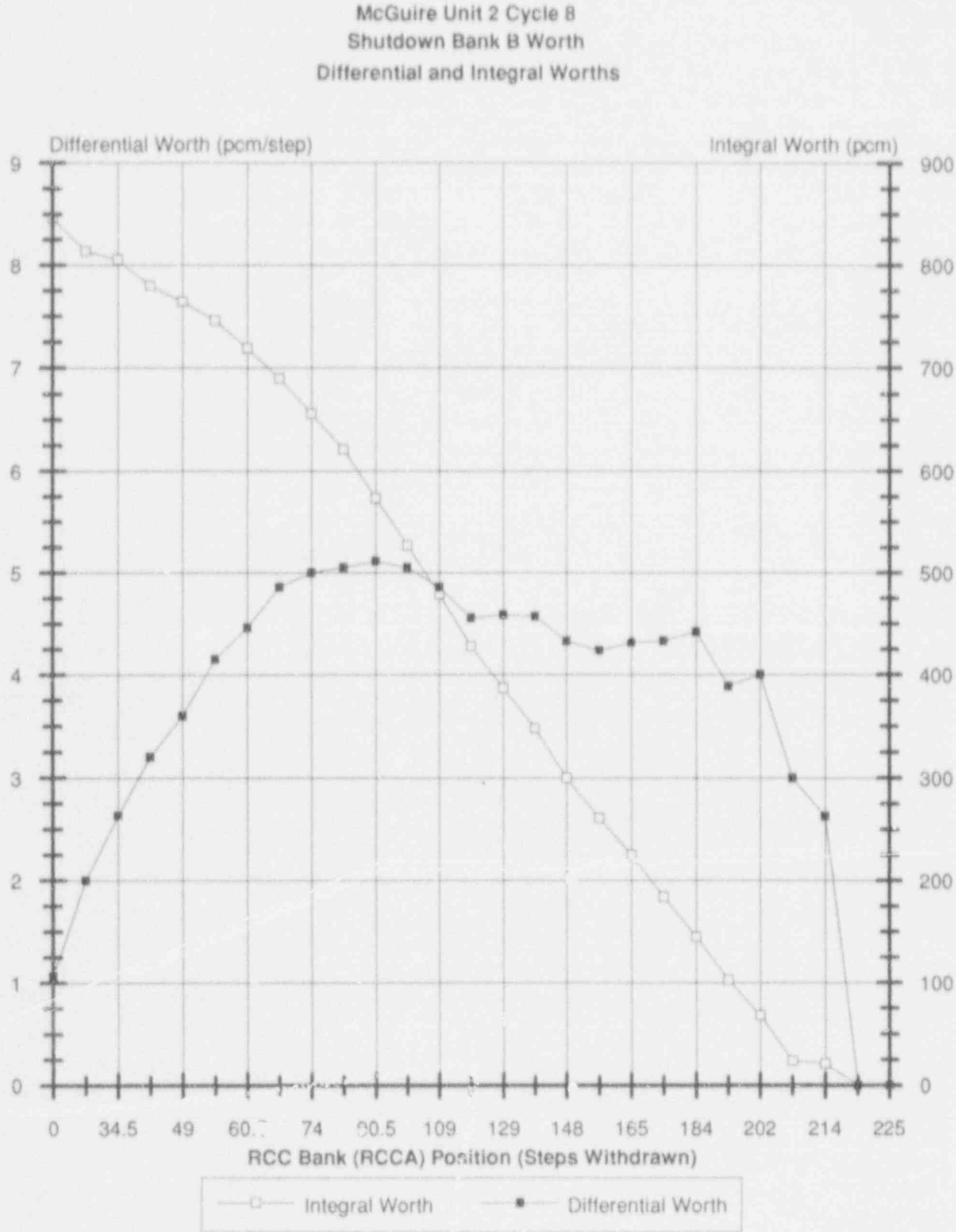


3.3 Control Rod Worth Measurement - PT/0/A/4150/11

On March 16, 1992, Shutdown Bank B rod worth was measured using the established boration/dilution method. There were no other rods in the core at the time. Shutdown Bank B was predicted to be the highest worth bank and was measured using this method so as to serve as the reference bank for Control Rod Worth Measurements by Rod Swap.

The measured worth of Shutdown Bank B was 846 pcm. The predicted worth was 882 pcm with an allowable band of ±132 pcm. This represented an error of 4.1% and was within the acceptance criterion of ±15%. Figure 5 shows the measured integral and differential rod worths for Shutdown Bank B.

Figure 5



McGuire Unit 2 Cycle 8
Shutdown Bank B Worth
Differential and Integral Worths
Differential Worth (pcm/step)
Integral Worth (pcm)
9
8
7
6
5
4
3
2
1
0
900
800
700
600
500
400
300
200
100
0
0
34.5
49
74
109
129
148
165
184
202
214
225
RCC Bank (RCCA) Position (Steps Withdrawn)
Integral Worth
Differential Worth

3.4 Control Rod Worth Measurement: Rod Swap - PT/0/A/4150/11A

On March 16/17, 1992, the rod swap method of control rod worth measurement was begun. Shutdown Bank B was used as the reference bank and its worth was measured by the boration/dilution method (see Section 3.3).

With the reference bank essentially all the way in and the reactor just critical, each control and shutdown bank was measured via rod exchange. The integral worth of the bank being measured (i.e., the test bank) was determined from the difference in the critical rod position of the reference bank with and without the test bank in the core.

The measured bank worths were compared with predicted worths and all banks were within the acceptance criteria of ±30% or ±200 pcm whichever was greater. The measured total rod worth was >90% of the predicted worth which met the acceptance criteria. In addition, all review criteria were met.

The results of the rod exchange test are given on Table 4.

TABLE 4

Control Rod Worth Measurement: Rod Swap

Bank Identification	Predicted Worth pcm	Measured Worth pcm ++	Percent + Difference
Control Bank C (predicted reference bank)	882	846 *	4.3
Control Bank A	330	335	-1.5
Control Bank B	693	644	7.6
Control Bank C	842	817	3.1
Control Bank D	503	496	1.4
Shutdown Bank A	292	278	5.0
Shutdown Bank C	411	386	6.5
Shutdown Bank D	411	381	7.9
Shutdown Bank E	426	406	4.9
Total Rod Worth	**4790**	**4589**	**4.4**

* Measured by boration / dilution method

$$+ \left| \frac{Predicted}{Measured} - 1 \right| \times 100$$

++ Rounded to nearest pcm

4.0 Power Escalation Testing

McGuire Unit 2 Cycle 8 Power Escalation testing started March 17, 1992, at the conclusion of ZPPT and was completed March 28, 1992.

The unit went on line March 17 at 1243 hours. The unit experienced some holds during power escalation which were scheduled to allow testing per PT/0/A/4150/21, Post Refueling Controlling Procedure for Criticality, Zero Power Physics, and Power Escalation Testing, and to allow Chemistry testing.

At ~38% power on March 20, 1992, PT/0/A/4150/02A, Core Power Distribution and Incore/NIS Correlation Check, was performed. Table 5 shows the full core flux map results based on PT/0/A/4150/02A. The results from the full core flux map taken were used to project a "limiting" power at which F_Q or $F_{\Delta H}$ Tech Spec peaking factor margin would be maintained. This projection indicated that the F_Q Tech Spec peaking factor margin would be maintained to 91.1% power. PT/0/A/4600/02F, Incore and Nuclear Instrumentation Systems Interim Recalibration, was also performed at ~38% power. The results of this test were used as calibration data for the Power Range excore detectors. Table 6 shows the test results.

At ~78% power on March 23, 1992, PT/0A/4150/02A, Core Power Distribution and Incore/NIS Correlation Check, was performed. The test results are given in Table 7. The results of the NIS correlation check indicated a difference between incore and excore AFD to be 2.041% for Quadrant 1. PT/0/A/4600/02F, Incore and Nuclear Instrumentation Systems Interim Recalibration, was therefore completed at ~78% power. The results of this test were used as calibration data for the Power Range excore detectors. Table 8 shows the test results. The results from the full core flux map taken were used to project a "limiting" power at which F_Q or $F_{\Delta H}$ Tech Spec peaking factor margin would be maintained. This projection indicated that both the $F_{\Delta H}$ Tech Spec peaking factor margin and the F_Q Tech Spec peaking factor margin would be maintained for power levels up to 100% power.

Power escalation then resumed at a rate of ~2.5%/hr. Upon achieving ~90%, PT/0/A/4150/03, Thermal Power Output Measurement, was performed (see Section 4.1). The remaining tests designated for Hot full Power Equilibrium Conditions were performed on March 27-28, 1992. The tests and their results are described in Sections 4.2 - 4.4.

TABLE 5

M2C8 Core Power Distribution Results
38% Full Power

NOTE: Axial location 1 is the bottom of the core.
Axial location 61 is the top of the core.

Unit 2 Cycle 8	Map M2C8F001
Date/Time Map Taken	3/20/92 0400 hours
Power Level	37.82%
Cycle Burnup	0.5 EFPD 20.2 MWD/MTU
Boron Concentration	1489 ppm
Control Rod Position	Control Bank D at 178 steps withdrawn
Maximum F^T SUB Q	1.8637 at Axial Loc. 40, Horiz. Loc. E-14
Maximum pin F^N SUB ΔH	1.4594 at Horiz. Loc. L-14
Maximum Reaction Rate error (from predicted)	7.98% at Horiz. Loc. B-06
Minimum F-SUB-Q-OP Margin 24.7427%	Location M-11
Minimum F-SUB-Q-RPS Margin 11.0820%	Location J-10
Minimum F-DELTA-H Margin 38.1236%	Location M-11
Total Incore Axial Offset	7.407%

Incore Tilts:

Upper Core	Lower Core
Quadrant 1: -2.184%	Quadrant 1: -1.681%
Quadrant 2: 1.417%	Quadrant 2: 0.654%
Quadrant 3: 1.750%	Quadrant 3: 1.138%
Quadrant 4: -0.983%	Quadrant 4: -0.111%

Table 6

OP/2/A/6100/22

ENCLOSURE 4.3

TABLE 2.2

Excore Currents and Voltages
Correlated to 100% Full Power
at Various Axial Offsets

Unit 2 Cycle 8

FULL POWER DETECTOR CURRENTS (MICROAMPS) CORRESPONDING TO VARIOUS INCORE AXIAL OFFSETS

INCORE AXIAL OFFSET	DETECTOR N-41		DETECTOR N-42		DETECTOR N-43		DETECTOR N-44	
	T	B	T	B	T	B	T	B
30.0	262.9	201.8	337.4	249.2	294.2	223.7	289.6	216.1
20.0	247.8	219.6	318.3	270.8	277.6	243.0	273.3	233.8
10.0	232.7	237.5	299.1	292.4	261.0	262.4	257.1	251.5
0.0	217.6	255.3	280.0	314.0	244.3	281.7	240.8	269.2
-10.0	202.5	273.1	260.9	335.6	227.7	301.1	224.5	287.0
-20.0	187.4	291.0	241.7	357.2	2[illegible]1.1	320.4	208.3	304.7
-30.0	172.3	308.8	222.6	378.8	194.5	339.8	192.0	322.4
r^2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

NORMALIZED DETECTOR VOLTAGES (VOLTS) AT VARIOUS AXIAL OFFSETS

INCORE AXIAL OFFSET	DETECTOR N-41			DETECTOR N-42			DETECTOR N-43			DETECTOR N-44		
	T	B	T-B	T	B	T-B	T	B	T-B	T	B	T-B
30.0	10.064	6.584	3.480	10.038	6.611	3.427	10.029	6.614	3.416	10.018	6.686	3.332
20.0	9.486	7.166	2.320	9.468	7.184	2.284	9.463	7.186	2.277	9.455	7.234	2.222
10.0	8.908	7.748	1.160	8.899	7.757	1.142	8.896	7.758	1.139	8.893	7.782	1.111
0.0	8.330	8.330	0.000	8.330	8.330	0.000	8.330	8.330	0.000	8.330	8.330	0.000
-10.0	7.752	8.912	-1.160	7.761	8.903	-1.142	7.764	8.902	-1.139	7.767	8.878	-1.111
-20.0	7.174	9.494	-2.320	7.192	9.476	-2.284	7.197	9.474	-2.277	7.205	9.426	-2.222
-30.0	6.596	10.076	-3.480	6.622	10.049	-3.427	6.631	10.046	-3.416	6.642	9.974	-3.332

AFD INCORE/EXCORE RATIOS FOR QUADRANTS 1 - 4

QUAD 4	QUAD 2	QUAD 1	QUAD 3
N-41	N-42	N-43	N-44
M = 1.436	M = 1.459	M = 1.463	M = 1.500

PREPARED BY _____ DATE 3/20/92

TABLE 7

M2C8 Core Power Distribution Results
78% Full Power

NOTE: Axial location 1 is the bottom of the core.
Axial location 61 is the top of the core.

Unit 2 Cycle 8	Map M2C8F002
Date/Time Map Taken	3/23/92 0050 hours
Power Level	77%
Cycle Burnup	1.63 EFPD 66 MWD/MTU
Boron Concentration	1410 ppm
Control Rod Position	Control Bank D at 199/198 steps withdrawn
Maximum F^T SUB Q	1.6981 at Axial Loc. 35, Horiz. Loc. J-10
Maximum pin F^N SUB ΔH	1.4520 at Horiz. Loc. J-10
Maximum Reaction Rate error (from predicted)	5.11% at Horiz. Loc. B-08
Minimum F-SUB-Q-OP Margin 6.7815%	Location F-09
Minimum F-SUB-Q-RPS Margin 11.2082%	Location J-10
Minimum F-DELTA-H Margin .0615%	Location G-12
Total Incore Axial Offset	1.146%

Incore Tilts:

Upper Core	Lower Core
Quadrant 1: -1.382%	Quadrant 1: -0.707%
Quadrant 2: 0.899%	Quadrant 2: 0.373%
Quadrant 3: 1.295%	Quadrant 3: 0.515%
Quadrant 4: -0.813%	Quadrant 4: -0.182%

Table 3

OP/2/A/6100/22

ENCLOSURE 4.1

TABLE 2.2

Excore Currents and Voltages
Correlated to 100% Full Power
at Various Axial Offsets

Unit 2 Cycle 8

FULL POWER DETECTOR CURRENTS (MICROAMPS) CORRESPONDING TO VARIOUS INCORE AXIAL OFFSETS

INCORE AXIAL OFFSET	DETECTOR N-41		DETECTOR N-42		DETECTOR N-43		DETECTOR N-44	
	T	B	T	B	T	B	T	B
30.0	276.8	206.0	354.6	253.9	312.7	230.0	302.3	218.7
20.0	260.9	224.2	334.5	275.9	295.0	249.9	285.3	236.6
10.0	245.0	242.4	314.4	297.9	277.4	269.8	268.3	254.6
0.0	229.1	260.6	294.3	319.9	259.7	289.6	251.3	272.5
-10.0	213.2	278.9	274.2	342.0	242.1	309.5	234.4	290.4
-20.0	197.3	[illegible]	254.1	364.0	224.4	329.4	217.4	308.4
-30.0	181.4	315.3	234.0	[illegible]	206.8	349.3	200.4	326.3
r^2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

NORMALIZED DETECTOR VOLTAGES (VOLTS) AT VARIOUS AXIAL OFFSETS

INCORE AXIAL OFFSET	DETECTOR N-41			DETECTOR N-42			DETECTOR N-43			DETECTOR N-44		
	T	B	T-B	T	B	T-B	T	B	T-B	T	B	T-B
30.0	10.064	6.583	3.481	10.037	6.610	3.426	10.028	6.615	3.414	10.019	6.685	3.333
20.0	9.486	7.166	2.321	9.468	7.184	2.284	9.462	7.186	2.276	9.456	7.234	2.222
10.0	8.908	7.748	1.160	8.899	7.757	1.142	8.896	7.758	1.138	8.893	7.782	1.111
0.0	8.330	8.330	0.000	8.330	8.330	0.000	8.330	8.330	0.000	8.330	8.330	0.000
-10.0	7.752	8.912	-1.160	7.761	8.903	-1.142	7.764	8.902	-1.138	7.767	8.878	-1.111
-20.0	7.174	9.494	-2.321	7.192	9.476	-2.284	7.198	9.474	-2.276	7.204	9.426	-2.222
-30.0	6.596	10.077	-3.481	6.623	10.050	-3.426	6.632	10.045	-3.414	6.641	9.975	-3.333

AFD INCORE/EXCORE RATIOS FOR QUADRANTS 1 - 4

QUAD 4 N-41	QUAD 2 N-42	QUAD 1 N-43	QUAD 3 N-44
M = 1.436	M = 1.459	M = 1.464	M = 1.499

PREPARED BY CW Toben DATE 3/23/92

4.1 Thermal Power Output Measurement - PT/0/A/4150/03

This test was used to verify that the primary and secondary heat balances on the plant computer were consistent with primary and secondary heat balances on a benchmarked offline computer. The test was run on March 23/24, 1992, at 90% F.P. The results are shown in Table 9.

The acceptance criterion of 1% difference between the offline computer and the plant computer was met.

TABLE 9

Thermal Power Output Measurement Results

	Plant Computer		Off-Line Computer	
	%	MW_t	%	MW_t
Primary Heat Balance	90.776	3096.391	90.97	3103.0
Secondary Heat Balance	90.398	3083.516	90.39	3083.203

4.2 Reactivity Anomalies Calculation - PT/0/A/4150/04

This test compared the actual core reactivity to the predicted core reactivity by taking into account the actual Reactor Coolant System boron concentration, Xenon and Samarium worths, rod positions and power level and adjusting these to the ARO, Hot Full Power (HFP), equilibrium Xenon and Samarium condition. Theoretical and actual Reactor Coolant System boron concentration for these conditions were then compared.

The test, performed at ~100% on March 27, 1992, indicated that the actual ARO, HFP, equilibrium Xenon and Samarium condition boron concentration was 1188.9 ppm. This compares to a predicted value of 1202.8 ppm. The 13.9 ppm difference translated into a 109.5 pcm error between actual and predicted reactivity worths. This was within the acceptance criterion for the test of ±1000 pcm.

4.3 Core Power Distribution and Incore/NIS Correlation Check - PT/0/A/4150/02A

On March 27, 1992, PT/0/A/4150/02A, Core Power Distribution and and Incore/NIS Correlation Check, was performed at ~100% Full Power and equilibirum conditions.

The indicated incore axial flux difference (AFD) from flux map M2C8F004 was -2.035%. The results of this test indicated at the maximum absolute difference between the AFD from any Power Range excore detector channel and the indicated incore AFD from the full core flux map was <3%. The results of the test are summarized in Table 10.

TABLE 10

M2C8 Core Power Distribution Results
-100% Full Power

NOTE: Axial location 1 is the bottom of th ore.
Axial location 61 is the top of the core.

Unit 2 Cycle 8	Map M2C8F004
Date/Time Map Taken	3/27/92 1000 hours
Power Level	-100%
Cycle Burnup	5.79 EFPD 234 MWD/MTU
Boron Concentration	1198 ppm
Control Rod Position	Control Bank D at 211 steps withdrawn
Maximum F^T SUB Q	1.6585 at Axial Loc. 34, Horiz. Loc. G-10
Maximum pin F^N SUB ΔH	1.4337 at Horiz. Loc. G-10
Maximum Reaction Rate error (from predicted)	5.16% at Horiz. Loc. B-06
Minimum F-SUB-Q-OP Margin 3.5437%	Location M-07
Minimum F-SUB-Q-RPS Margin 11.3242%	Location L-14
Minimum F-DELTA-H Margin 4.2350%	Location G-12
Total Incore Axial Offset	-2.035%

Incore Tilts:

Upper Core	Lower Core
Quadrant 1: -1.561%	Quadrant 1: -0.603%
Quadrant 2: 1.493%	Quadrant 2: 0.497%
Quadrant 3: 1.002%	Quadrant 3: 0.329
Quadrant 4: -0.934%	Quadrant 4: -0.223%

4.5 Incore and Nuclear Instrumentation Systems Recalibration - PT/1/A/4600/02G

This test was performed on March 27-28, 1992, to obtain recalibration data for the excore detectors based on the incore axial offsets. The NIS amplifier gains, the f(ΔI) reset function for the over-power differential temperature protective setpoints, and the OAC excore power distribution monitor were all calibrated on March 31, 1992. The results of the test are given in Table 11.

Table 11

OP/2/A/6100/22
ENCLOSURE 4.3
TABLE 2.2
Excore Currents and Voltages
Correlated to 100% Full Power
at Various Axial Offsets

Unit 2 Cycle 0

FULL POWER DETECTOR CURRENTS (MICROAMPS) CORRESPONDING TO VARIOUS INCORE AXIAL OFFSETS

INCORE AXIAL OFFSET	DETECTOR N-41 T	DETECTOR N-41 B	DETECTOR N-42 T	DETECTOR N-42 B	DETECTOR N-43 T	DETECTOR N-43 B	DETECTOR N-44 T	DETECTOR N-44 B
30.0	290.1	203.8	370.8	254.9	324.3	228.6	312.3	216.6
20.0	273.7	225.5	350.3	280.2	307.0	252.0	295.6	238.0
10.0	257.3	247.1	329.8	305.4	289.8	275.4	279.0	259.3
0.0	240.9	268.7	309.2	330.7	272.5	298.8	262.4	280.6
-10.0	224.5	290.4	288.8	355.9	255.3	322.2	245.7	302.0
-20.0	208.0	312.0	268.3	381.1	238.1	345.6	229.1	323.3
-30.0	191.6	333.7	247.8	406.4	220.8	369.0	212.4	344.7
r^2	0.9977	0.9968	0.9981	0.9976	0.9971	0.9960	0.9970	0.9964

NORMALIZED DETECTOR VOLTAGES (VOLTS) AT VARIOUS AXIAL OFFSETS

INCORE AXIAL OFFSET	DETECTOR N-41 T	DETECTOR N-41 B	DETECTOR N-41 T-B	DETECTOR N-42 T	DETECTOR N-42 B	DETECTOR N-42 T-B	DETECTOR N-43 T	DETECTOR N-43 B	DETECTOR N-43 T-B	DETECTOR N-44 T	DETECTOR N-44 B	DETECTOR N-44 T-B
30.0	10.033	6.318	3.715	9.986	6.422	3.564	9.911	6.374	3.537	9.916	6.430	3.486
20.0	9.465	6.988	2.477	9.434	7.058	2.376	9.384	7.026	2.358	9.387	7.063	2.324
10.0	8.898	7.659	1.238	8.882	7.694	1.188	8.857	7.678	1.179	8.859	7.697	1.162
0.0	8.330	8.330	0.000	8.330	8.330	0.000	8.330	8.330	0.000	8.330	8.330	0.000
-10.0	7.762	9.001	-1.238	7.778	8.966	-1.188	7.803	8.982	-1.179	7.801	8.963	-1.162
-20.0	7.195	9.672	-2.477	7.226	9.602	-2.376	7.276	9.634	-2.358	7.273	9.597	-2.324
-30.0	6.627	10.342	-3.715	6.674	10.238	-3.564	6.749	10.286	-3.537	6.744	10.230	-3.486

AFD INCORE/EXCORE RATIOS FOR QUADRANTS 1 - 4

QUAD 4 N-41	QUAD 2 N-42	QUAD 1 N-43	QUAD 3 N-44
M = 1.045	M = 1.402	M = 1.413	M = 1.434

PREPARED BY [signature] DATE 3/28/92

Duke Power Company
Wachovia Center
P.O. Box 1007
Charlotte, N.C. 28201-1007

DUKE POWER

June 16, 1992

Mr. Rex Gleason
Regional Manager
Water Quality Section
Department of Environmental, Health and Natural Resources
919 North Main Street
Mooresville, N. C. 28115

Subject: Marshall Steam Station
NPDES Permit NC0004987
Release of Domestic Wastewater
File: Ms-704.01, MS-704.21
Certified: P067 125 0850

Dear Mr. Gleason:

Pursuant to Part II, Section D (6)(C) of Marshall Steam Station's NPDES permit (NC0004987), this is a follow-up written report to the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR) of recent noncompliances associated with Marshall's sanitary treatment system. Telephone notifications were made to Mr. Mike Parker of the Mooresville Regional office on June 3 and 5, 1992, by Ms. Norma Atherton of Duke Power Company.

EVENTS

On June 2, 1992, due to maintenance rinsing activities, water from a fire hose inadvertently entered the domestic wastewater package plant through a manhole cover. The manhole cover, which was located in a paved traffic area, is solid except for several one inch holes.

The package plant was unable to process this surge of water and, as a result, the facility overflowed for approximately three and one half hours via an overflow line. The overflow discharged to Lake Norman at the Marshall intake canal.

On June 4, 1992, a rainfall event that produced 1.7 inches of rain within 2 hours caused rainwater to enter the sanitary system through the manhole cover referenced above. The sanitary treatment system overflowed to the intake canal for approximately 1 hour via the overflow line.

C001 1/0

CORRECTIVE ACTIONS

A review was made of all existing sanitary system manhole covers. Two manhole covers were replaced with solid manhole covers, including the manhole cover in question, and sealed in place with a sealant. No additional covers were identified that would allow surface water infiltration.

The overflow line from the sanitary treatment facility was "capped" by removing the elbow connection from the chlorination chamber and inserting a blank flange. For long term corrective action, a design study is being initiated to evaluate the possible upgrade of the sanitary treatment system. Recommendations from the design study and time tables will be provided as this information becomes available to us.

Operations personnel have been reminded to check both the number two sump and the sanitary system levels if a civil alarm is received in the control room. This alarm is a shared alarm between the two locations.

Should you have any questions, please contact Norma Atherton at (704)382-2116.

Sincerely,

Norma G. Atherton

Norma G. Atherton, Production Specialist II
Generation Services Department
Environmental Division

NGA/jfw

cc: NCDEHNR - Raleigh

bc: G. S. Rice
J. R. Hendricks
J. S. Carter
D. L. Burrell
B. E. Davis
Central Records
NRC Document Control Desk