VEP-NOS-3

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NORTH ANNA UNIT 2, CYCLE 2 CORE PERFORMANCE REPORT

NUCLEAR OPERATIONS DEPARTMENT

Virginia Electric and Power Company

VEP-NOS-3

NORTH ANNA UNIT 2, CYCLE 2
CORE PERFORMANCE REPORT

by

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Section 1

INTRODUCTION AND SUMMARY

On April 2, 1983, North Anna Unit 2 completed Cycle 2. Since the initial criticality of Cycle 2 on July 2, 1982, the reactor core produced approximately 50 x 10^6 MBTU (8,436 Megawatt days per metric ton of contained uranium) which has resulted in the generation of approximately 4.8 x 10^9 KWHr gross (4.6 x 10^9 KWHr net) of electrical energy. The purpose of this report is to present an analysis of the core performance for routine operation during Cycle 2. The physics tests that were performed during the startup of this cycle were covered in the North Anna Unit 2, Cycle 2 Startup Physics Test Report[1] and, therefore, will not be included here.

The second cycle core consisted of five batches of fuel. The North Anna 2, Cycle 2 core loading map specifying the fuel batch identification, fuel assembly locations, burnable poison locations and source assembly locations is shown in Figure 1.1. Movable detector locations and thermocouple locations are identified in Figure 1.2. Control rod locations are shown in Figure 1.3.

Routine core follow involves the analysis of four principal performance indicators. These are burnup distribution, reactivity depletion, power distribution, and primary coolant activity. The core burnup distribution is followed to verify both burnup symmetry and proper batch burnup sharing, thereby ensuring that the fuel held over for the next cycle will be compatible with the new fuel that is inserted. Reactivity depletion is monitored to detect the existence of any abnormal reactivity behavior, to determine if the core is depleting as designed, and to indicate at what burnup level refueling will be required. Core power distribution follow includes the monitoring of nuclear hot channel factors to verify that they are within the Technical Specifications[2] limits thereby ensuring that adequate margins to linear power density and critical heat flux thermal limits are maintained. Lastly, as part of normal core follow, the primary coolant activity is monitored to verify that the dose equivalent iodine-131 concentration is within the limits specified by the North Anna Unit 2 Technical Specifications, and to assess the integrity of the fuel.

Each of the four performance indicators is discussed in detail for the North Anna 2, Cycle 2 core in the body of this report. The results are summarized below:

1. Burnup Follow - The burnup tilt (deviation from quadrant symmetry) on the core was no greater than ±0.31% with the burnup accumulation in each batch deviating from design prediction by less than 3.2%.

2. Reactivity Depletion Follow - The critical boron concentration, used to monitor reactivity depletion, was consistently within ±0.47% ΔK/K of the design prediction which is well within the ±1% ΔK/K margin allowed by Section 4.1.1.1.2 of the Technical Specifications.

3. Power Distribution Follow - Incore flux maps taken each month indicated that the assemblywise radial power distributions deviated from the design predictions by an average difference of less than 4%. The radial heat flux hot channel factor, F-XY, which violated its surveillance limits during the first third of the cycle, is described in Section 4 of this report. All hot channel factors met their respective Technical Specifications limits.

4. Primary Coolant Activity Follow - The average dose equivalent iodine-131 activity level in the primary coolant during Cycle 2 was approximately 4.0×10^{-2} µCi/gm. This corresponds to 4% of the operating limit for the concentration of radioiodine in the primary coolant.

In addition, the effects of fuel densification were monitored throughout the cycle. No densification effects were observed.

Figure 1.1

NORTH ANNA UNIT 2 - CYCLE 2

CORE LOADING MAP

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							R07	R31	R36						
2					R20	R50	R39 8P	N30	R45 8P	R17	R27				
3				R15	R02 12P	N01	N34	N37 SS	N11	N10	R03 12P	R24			
4			R33	P25	N26	P13	P16	P31	P34	P48	N13	P14	R05		
5		R13	R11 12P	N32	N29	P17	P06	N50	P04	P45	N48	N36	R38 12P	R25	
6		R47	N04	P27	P08	N44	P30 8P	N38	P23 8P	N27	P19	P51	N52	R10	
7	R30	R42 8P	N49	P47	P46	P20 8P	N19	P05	N20	P38 8P	P33	P15	N21	R41 8P	R14
8	R04	N14	N41	P41	N45	C22	P43	L51	P49	C31	N28	P52	N42	N35	R51
9	R26	R34 8P	N47	P01	P40	P37 8P	N02	P02	N17	P24 8P	P39	P35	N06	R22 8P	R40
10		R48	N23	P42	P36	N08	P29 8P	N25	P11 8P	N24	P07	P12	N22	R08	
11		R28	R46 12P	N12	N39	P03	P50	N46	P26	[illegible]	N15	N05	R44 12P	R23	
12			R16	P28	N33	P44	P09	P22	P18	P10	N51	P32	R29		
13				R01	R52 12P	N18	N31	N40 SS	N09	N16	R32 12P	R21			
14					R18	R43	R06 8P	N43	R35 8P	R12	R37				
15							R19	R49	R09						

--> ASSEMBLY ID
--> ONE OF THE FOLLOWING:
A. SS - SECONDARY SOURCE
B. XXP - BURNABLE POISON ASSEMBLY
(XX - NUMBER OF RODS)

	SUB-BATCH				
	1A2	2A2	3A	N1/3A3	4A
INITIAL ENRICHMENT (W/O U235)	2.110	2.600	3.100	3.102	3.414
ASSEMBLY TYPE	17X17	17X17	17X17	17X17	17X17
NUMBER OF ASSEMBLIES	1	50	52	2	52
FUEL RODS PER ASSEMBLY	264	264	264	264	264
ASSEMBLY IDENTIFICATION	L51	N01-N02, N04-N06, N08-N52	P01-P52	C22 C31	R01-R52

Figure 1.2

NORTH ANNA UNIT 2 - CYCLE 2

MOVABLE DETECTOR AND THERMOCOUPLE LOCATIONS

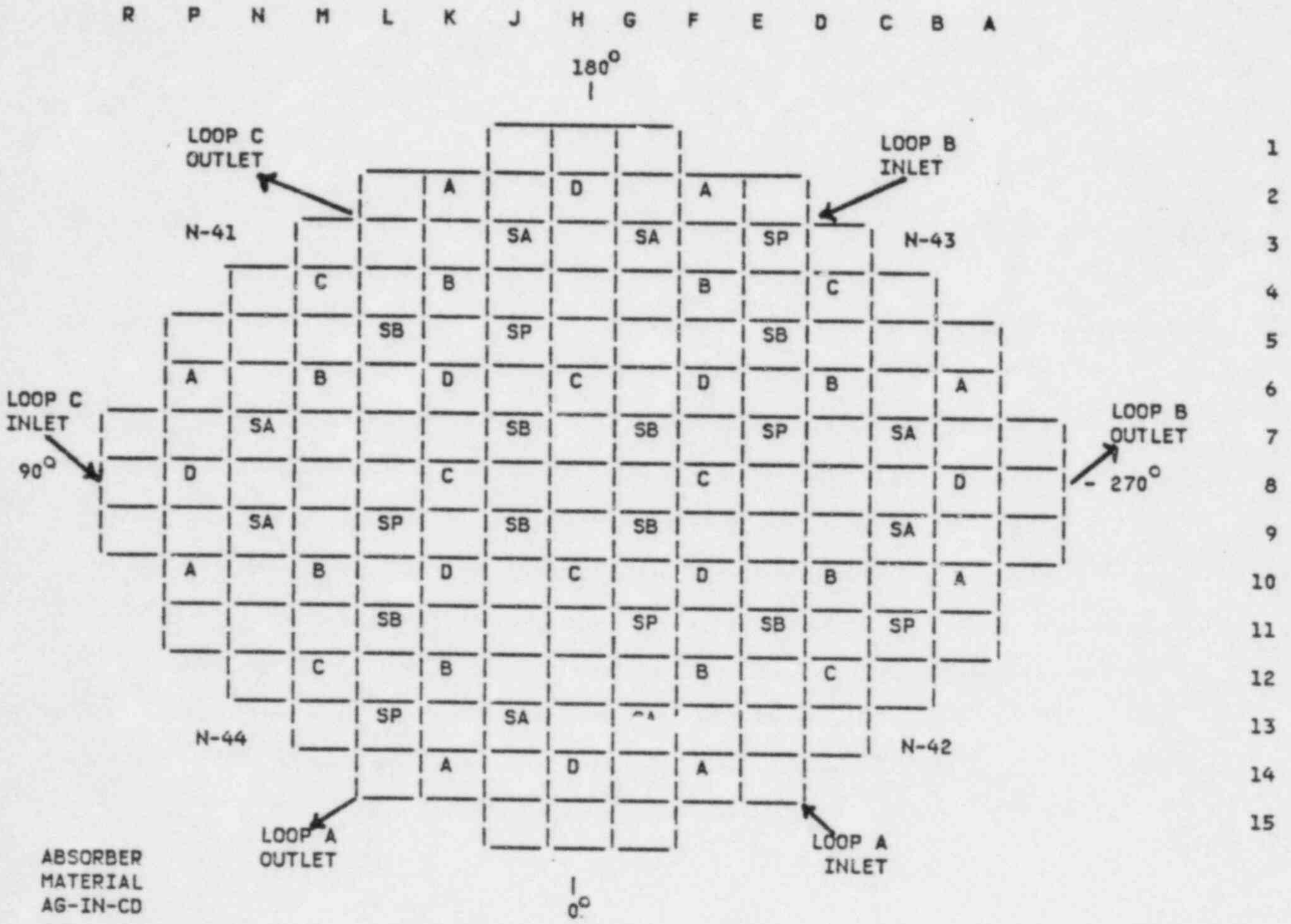
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1								MD	TC						
2							TC		TC	MD					
3				MD / TC		TC	MD	MD / TC		TC		MD / TC			
4			TC		MD			MD		MD	TC				
5			MD		MD	TC	MD	TC		TC	MD	MD / TC		MD / TC	
6			TC		MD / TC			MD	TC	MD					
7	TC	TC	MD				MD		MD		TC	MD		MD	
8	MD	TC	MD / TC		MD / TC	TC		TC	TC	MD	TC		MD / TC	MD	TC
9				TC	MD			TC	MD	MD / TC					MD
10			MD / TC				MD / TC				TC	MD		MD / TC	
11				TC	MD	TC		MD / TC		MD / TC	MD				
12			MD		TC		MD / TC				TC	MD	MD / TC		
13								MD / TC		MD / TC					
14					MD / TC				MD		TC				
15							MD	TC	TC						

MD - MOVABLE DETECTOR
TC - THERMOCOUPLE

Figure 1.3

NORTH ANNA UNIT 2 - CYCLE 2

CONTROL ROD LOCATIONS



ABSORBER
MATERIAL
AG-IN-CD

FUNCTION	NUMBER OF CLUSTERS
CONTROL BANK D	8
CONTROL BANK C	8
CONTROL BANK B	8
CONTROL BANK A	8
SHUTDOWN BANK SB	8
SHUTDOWN BANK SA	8
SP (SPARE ROD LOCATIONS)	8

Section 2

BURNUP FOLLOW

The burnup history for the North Anna Unit 2, Cycle 2 core is graphically depicted in Figure 2.1. The unit remained shut down from July 8, 1982 until August 30, 1982 for the removal of thermal sleeves and the replacement of a main station service transformer. The North Anna 2, Cycle 2 core achieved a burnup of 8,436 MWD/MTU. As shown in Figure 2.2, the average load factor for Cycle 2 was 72% when referenced to rated thermal power (2775 MW(t)).

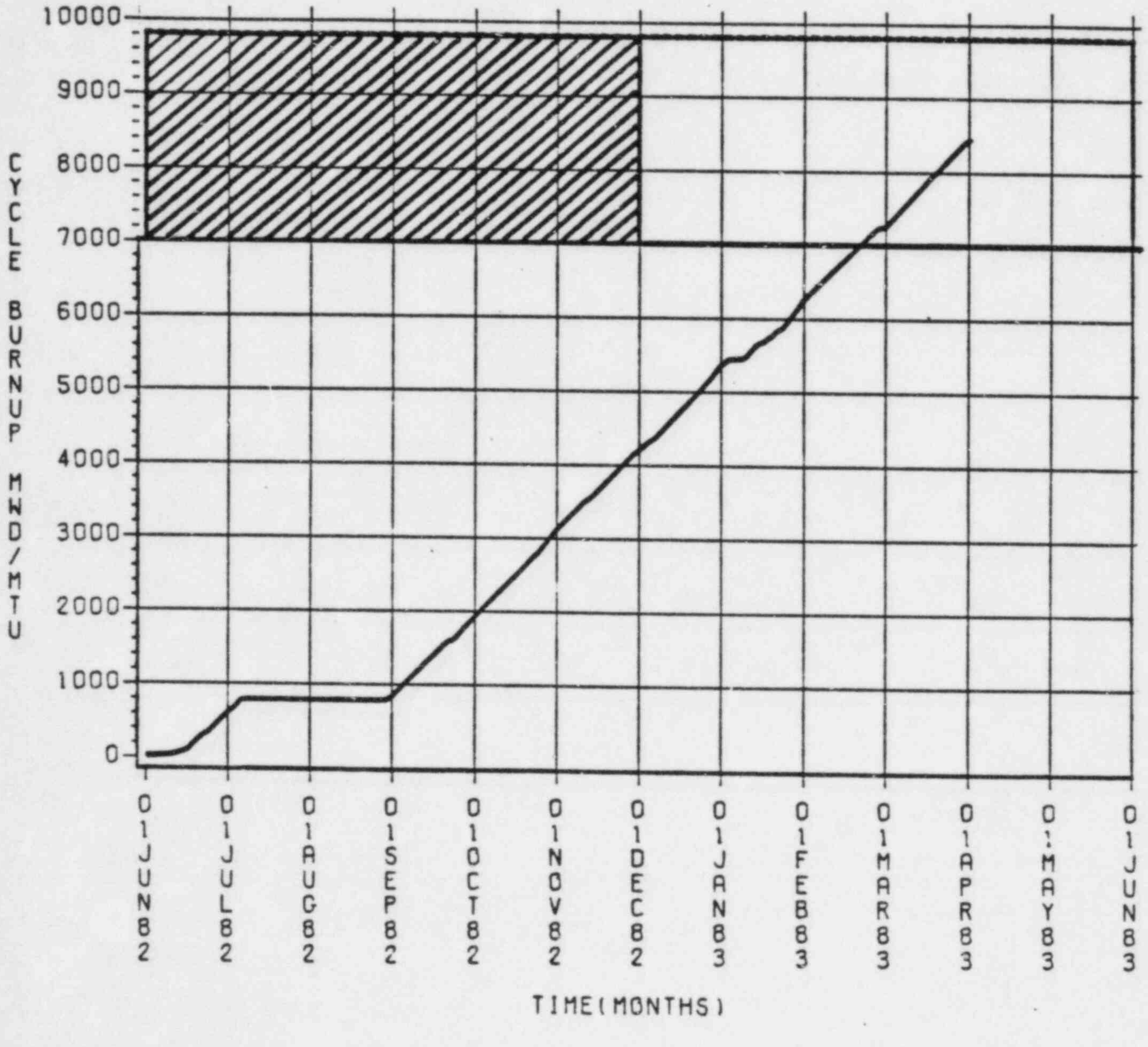
Radial (X-Y) burnup distribution maps show how the core burnup is shared among the various fuel assemblies, and thereby allow a detailed burnup distribution analysis. The NEWTOTE[3] computer code is used to calculate these assemblywise burnups. Figure 2.3 is a radial burnup distribution map in which the assemblywise burnup accumulation of the core at the end of Cycle 2 operation is given. For comparison purposes, the design values are also given. Figure 2.4 is a radial burnup distribution map in which the percentage difference comparison of measured and predicted assemblywise burnup accumulation at the end of Cycle 2 operation is also given. As can be seen from this figure, the accumulated assembly burnups were generally within ±5% of the predicted values. In addition, deviation from quadrant symmetry in the core, as indicated by the burnup tilt factors, was no greater than ±0.31%.

The burnup sharing on a batch basis is monitored to verify that the core is operating as designed and to enable accurate end-of-cycle batch burnup predictions to be made for use in reload fuel design studies. Batch definitions are given in Figure 1.1. As seen in Figure 2.5, the batch burnup sharing for North Anna Unit 2, Cycle 2 followed design predictions closely with each batch deviating less than 3.2% from design. Symmetric burnup in conjunction with agreement between actual and predicted assemblywise burnups and batch burnup sharing indicate that the Cycle 2 core did deplete as designed.

Figure 2.1

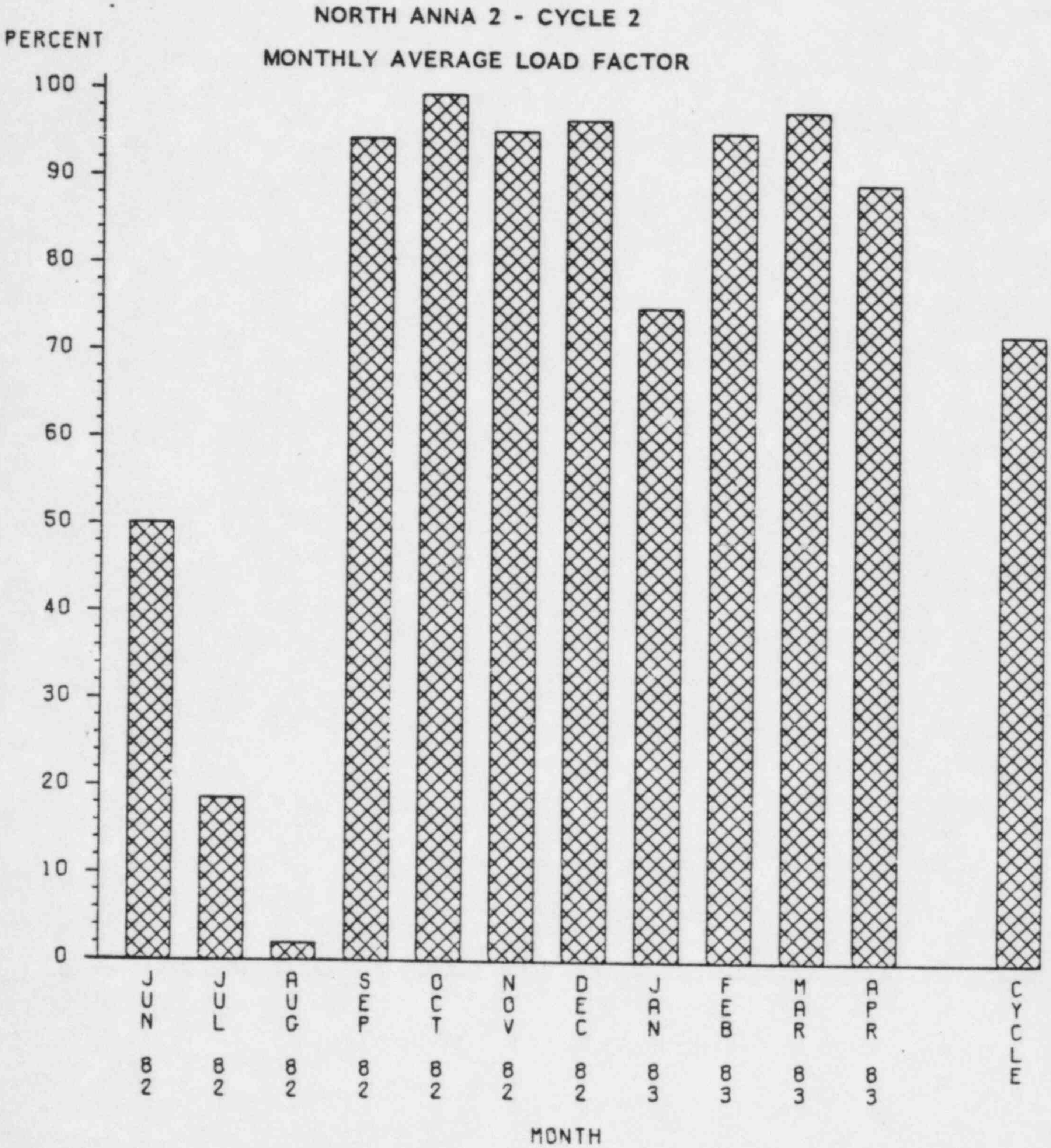
NORTH ANNA 2 - CYCLE 2

CORE BURNUP HISTORY



--- CYCLE 2 DESIGN BURNUP WINDOW - 7,000 TO 9,800 MWD/MTU

Figure 2.2



LOAD FACTOR = THERMAL ENERGY GENERATION IN MONTH(MWHT) / AUTHORIZED POWER LEVEL (MWT) X HOURS IN MONTH

(EXCLUDES REFUELING OUTAGES)

Figure 2.3

NORTH ANNA 2 - CYCLE 2
ASSEMBLYWISE ACCUMULATED BURNUP
MEASURED AND PREDICTED
(1000 MWD/MTU)

MEASURED / PREDICTED

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
1							6.09	7.45	6.05							1
							5.90	7.26	5.90							
2					6.16	8.53	9.66	24.99	9.70	8.52	6.18					2
					5.96	8.44	9.58	24.94	9.58	8.44	5.96					
3				6.52	9.24	25.26	25.31	23.36	25.11	25.05	9.20	6.71				3
				6.36	9.05	25.17	25.43	23.47	25.43	25.17	9.05	6.36				
4			6.46	16.96	24.87	18.55	23.50	20.25	23.63	18.48	24.72	16.86	6.63			4
			6.36	16.69	24.82	18.62	23.65	20.35	23.65	18.62	24.82	16.69	6.36			
5		5.98	9.02	24.80	23.60	21.96	23.28	23.52	23.57	21.74	23.66	24.90	9.31	6.20		5
		5.96	9.05	24.83	23.64	22.06	23.80	23.79	23.80	22.06	23.64	24.83	9.05	5.96		
6		8.43	25.09	18.32	22.08	24.37	18.35	25.17	18.53	24.77	21.79	18.79	25.39	8.60		6
		8.44	25.17	18.67	22.03	24.81	18.80	25.32	18.80	24.81	22.03	18.67	25.17	8.44		
7	6.13	9.57	25.40	23.46	23.57	18.28	23.22	17.93	23.20	18.50	23.21	23.40	25.44	9.72	6.05	7
	5.90	9.58	25.46	23.66	23.77	18.81	23.56	18.41	23.56	18.81	23.77	23.66	25.46	9.58	5.90	
8	7.50	24.95	24.91	19.93	23.31	31.26	17.90	20.70	17.92	30.81	23.54	20.10	23.64	25.23	7.59	8
	7.26	24.95	24.29	20.21	23.88	31.46	18.36	20.96	18.36	30.92	23.88	20.21	24.29	24.95	7.26	
9	6.12	9.67	25.64	23.48	23.32	18.47	23.19	18.13	23.09	18.45	23.25	23.69	25.49	9.98	6.26	9
	5.90	9.58	25.46	23.66	23.77	18.81	23.56	18.41	23.56	18.81	23.77	23.66	25.46	9.58	5.90	
10		8.64	25.35	18.54	21.66	24.45	18.51	24.86	18.61	24.51	21.72	18.64	25.18	8.82		10
		8.44	25.17	18.67	22.03	24.81	18.80	25.32	18.80	24.81	22.03	18.67	25.17	8.44		
11		6.20	9.33	24.91	23.43	21.98	23.61	23.41	23.48	21.77	23.54	24.97	9.30	6.21		11
		5.96	9.05	24.83	23.64	22.06	23.80	23.79	23.80	22.06	23.64	24.83	9.05	5.96		
12			6.64	16.69	24.86	18.55	23.16	20.11	23.78	18.59	24.99	17.00	6.66			12
			6.36	16.69	24.82	18.62	23.65	20.35	23.65	18.62	24.82	16.69	6.36			
13				6.73	9.71	25.59	25.57	23.54	25.76	25.42	9.36	6.62				13
				6.36	9.05	25.17	25.43	23.47	25.43	25.17	9.05	6.36				
14					6.41	9.09	9.93	25.20	9.75	8.72	6.26					14
					5.96	8.44	9.58	24.94	9.58	8.44	5.96					
15							6.41	7.57	6.03							15
							5.90	7.26	5.90							
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	

Figure 2.4

NORTH ANNA 2 - CYCLE 2

ASSEMBLYWISE ACCUMULATED BURNUP

COMPARISON OF MEASURED AND PREDICTED

(1000 MWD/MTU)

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
1							6.09	7.45	6.05							1
							3.18	2.68	2.53							
2					6.16	8.53	9.66	24.99	9.70	8.52	6.18					2
					3.35	1.07	0.81	0.24	1.18	0.90	3.71					
3				6.52	9.24	25.26	25.31	23.36	25.11	25.05	9.20	6.71				3
				2.39	2.06	0.33	-0.46	-0.44	-1.23	-0.48	1.61	5.35				
4			6.46	16.96	24.87	18.55	23.50	20.25	23.63	18.48	24.72	16.86	6.63			4
			1.45	1.60	0.21	-0.40	-0.64	-0.45	-0.11	-0.73	-0.40	1.00	4.09			
5		5.98	9.02	24.80	23.60	21.96	23.28	23.52	23.57	21.74	23.66	24.90	9.31	6.20		5
		0.35	-0.36	-0.12	-0.14	-0.43	-2.21	-1.13	-0.98	-1.42	0.12	0.30	2.81	3.94		
6		8.43	25.09	18.32	22.08	24.37	18.35	25.17	18.53	24.77	21.79	18.79	25.39	8.60		6
		-0.19	-0.30	-1.86	0.24	-1.78	-2.38	-0.61	-1.45	-0.14	-1.08	0.66	0.89	1.89		
7	6.13	9.57	25.40	23.46	23.57	18.28	23.22	17.93	23.20	18.50	25.21	23.40	25.44	9.72	6.05	7
	3.96	-0.15	-0.23	-0.86	-0.85	-2.85	-1.47	-2.62	-1.54	-1.68	-2.37	-1.09	-0.08	1.41	2.60	
8	7.50	24.95	24.91	19.93	23.31	31.26	17.90	20.70	17.92	30.81	23.54	20.10	23.64	25.23	7.59	8
	3.41	-0.01	2.56	-1.37	-2.37	-0.64	-2.50	-1.24	-2.39	-0.35	-1.43	-0.56	-2.65	1.11	4.62	
9	6.12	9.67	25.64	23.48	23.32	18.47	23.19	18.13	23.09	18.45	23.25	23.69	25.49	9.98	6.26	9
	3.69	0.95	0.72	-0.76	-1.89	-1.84	-1.57	-1.55	-2.03	-1.94	-2.19	0.12	0.13	4.09	6.15	
10		8.64	25.35	18.54	21.66	24.45	18.51	24.86	18.61	24.51	21.72	18.64	25.18	8.82		10
		2.27	0.74	-0.66	-1.67	-1.45	-1.55	-1.82	-0.99	-1.19	-1.43	-0.16	0.05	4.48		
11		6.20	9.33	24.91	23.43	21.98	23.61	23.41	23.48	21.77	23.54	24.97	9.30	6.21		11
		4.00	3.09	0.35	-0.89	-0.36	-0.80	-1.61	-1.38	-1.30	-0.43	0.58	2.70	4.21		
12			6.64	16.69	24.86	18.55	23.16	20.11	23.78	18.59	24.99	17.00	6.66			12
			4.31	-0.05	0.17	-0.39	-2.07	-1.15	0.54	-0.18	0.71	1.83	4.67			
13				6.73	9.71	25.59	25.57	23.54	25.76	25.42	9.36	6.62				13
				5.70	7.28	1.66	0.56	0.33	1.29	0.99	3.41	4.09				
14					6.41	9.09	9.93	25.20	9.75	8.72	6.26					14
					7.51	7.63	3.56	1.05	1.76	3.32	4.90					
15							6.41	7.57	6.03							15
							8.66	4.32	2.21							
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	

MEASURED
M/P % DIFF

ARITHMETIC AVG PCT DIFF = 0.66

STANDARD DEV = 1.66

AVG ABS PCT DIFF = 1.78

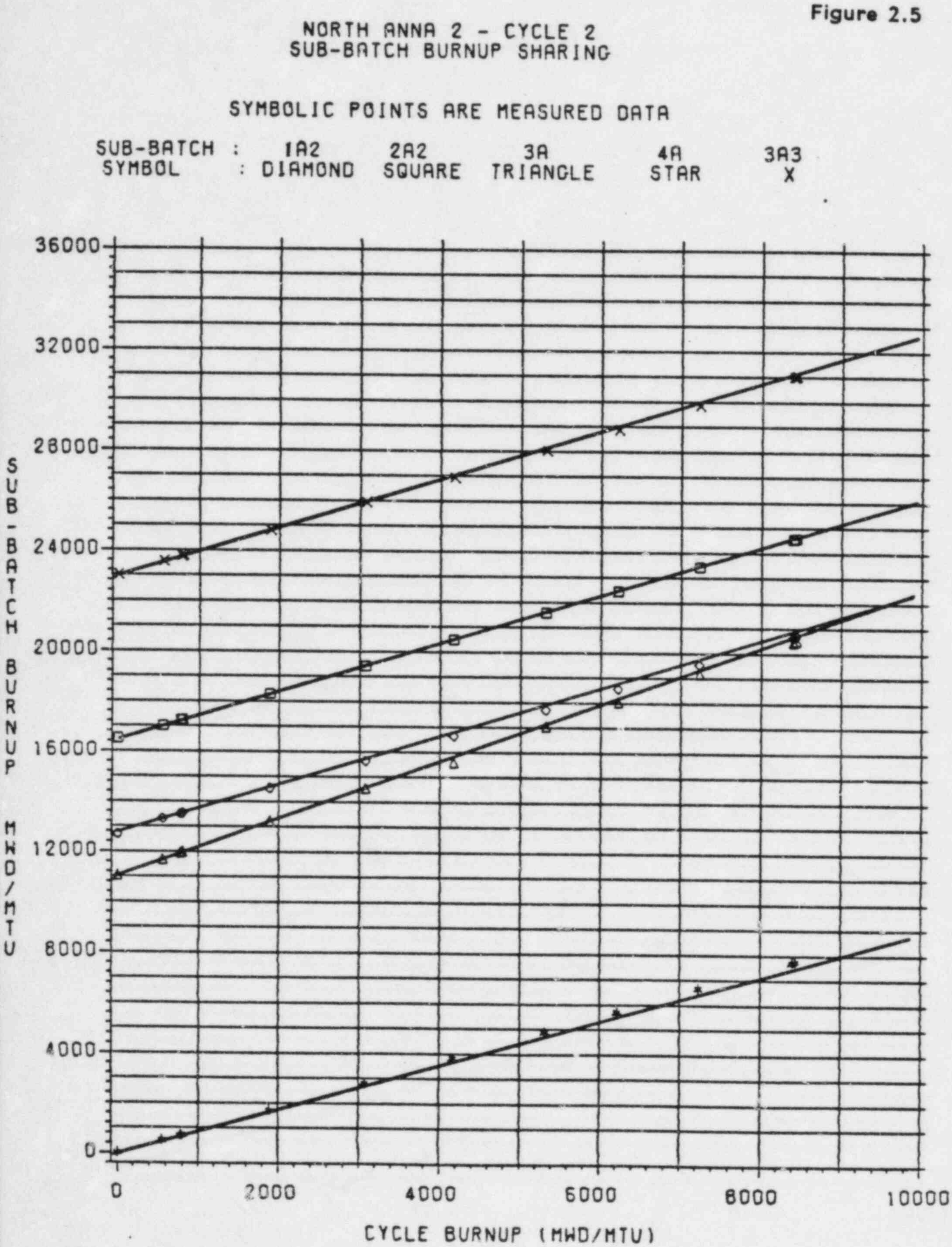
Burnup Sharing
(10^3 MWD/MTU)

Batch	Cycle 1	Cycle 2	Total
1A2	12.78	7.92	20.70
2A2	16.47	8.13	24.60
3A	11.06	9.44	20.50
4A	---	7.76	7.76
N1/3A3	---	8.02	31.04
Core Average		8.44	

Burnup Tilt

NW =	-0.31
NE =	-0.14
SW =	0.25
SE =	0.19

Figure 2.5

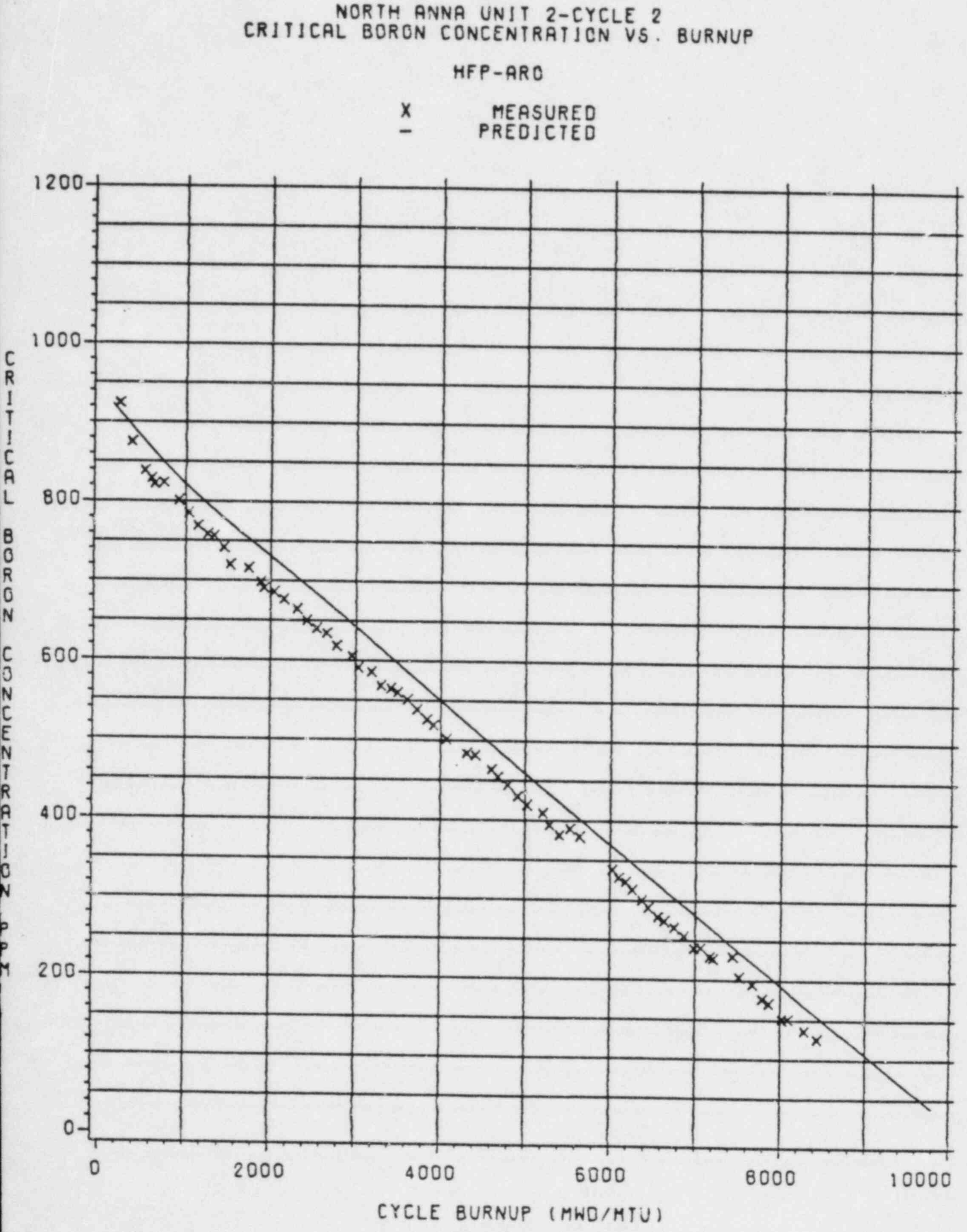

NORTH ANNA 2 - CYCLE 2
SUB-BATCH BURNUP SHARING
SYMBOLIC POINTS ARE MEASURED DATA
SUB-BATCH : 1A2 2A2 3A 4A 3A3
SYMBOL : DIAMOND SQUARE TRIANGLE STAR X
SUB-BATCH BURNUP MWD/MTU
CYCLE BURNUP (MWD/MTU)
0
2000
4000
6000
8000
10000
4000
8000
12000
16000
20000
24000
28000
32000
36000

Section 3

REACTIVITY DEPLETION FOLLOW

The primary coolant critical boron concentration is monitored for the purposes of following core reactivity and to identify any anomalous reactivity behavior. The FOLLOW[4] computer code was used to normalize "actual" critical boron concentration measurements to design conditions taking into consideration control rod position, xenon and samarium concentrations, moderator temperature, and power level. The normalized critical boron concentration versus burnup curve for the North Anna 2, Cycle 2 core is shown in Figure 3.1. It can be seen that the measured data typically compare to within 40 ppm of the design prediction. This corresponds to less than ±0.47% ΔK/K which is well within the ±1% ΔK/K criterion for reactivity anomalies set forth in Section 4.1.1.1.2 of the Technical Specifications. In conclusion, the trend indicated by the critical boron concentration verifies that the Cycle 2 core depleted as expected without any reactivity anomalies.

Figure 3.1



NORTH ANNA UNIT 2-CYCLE 2
CRITICAL BORON CONCENTRATION VS. BURNUP
HFP-ARO
X MEASURED
— PREDICTED
1200
1000
800
600
400
200
0
CRITICAL BORON CONCENTRATION PPM
0
2000
4000
6000
8000
10000
CYCLE BURNUP (MWD/MTU)

Section 4

POWER DISTRIBUTION FOLLOW

Analysis of core power distribution data on a routine basis is necessary to verify that the hot channel factors are within the Technical Specifications limits and to ensure that the reactor is operating without any abnormal conditions which could cause an "uneven" burnup distribution. Three-dimensional core power distributions are determined from movable detector flux map measurements using the INCORE[5] computer program. A summary of all full core flux maps taken since the completion of startup physics testing for North Anna 2, Cycle 2 is given in Table 4.1. Power distribution maps were generally taken at monthly intervals with additional maps taken as needed.

Radial (X-Y) core power distributions for a representative series of incore flux maps are given in Figures 4.1 through 4.3. Figure 4.1 shows a power distribution map that was taken early in cycle life. There are large differences (up to 11.7%) between measured and predicted relative assembly powers and this map also evidenced a violation of the radial peaking factor, F-XY. The average percent difference between measured and predicted assembly powers for this map was 3.3%. The magnitude of the F-XY violation (compared to the RTP surveillance limit) was less than 3%. These differences are due to the asymmetric core loading and quadrant power tilt that existed for Cycle 2. Following an evaluation of the heat flux hot channel factor, $F_Q(Z)$, in accordance with Technical Specification 4.2.2.2g, it was determined that sufficent margin existed in the design to allow full power operation without restriction. This violation persisted until approximately 3,000 MWD/MTU. Figure 4.2 shows a power distribution map that was taken near mid-cycle burnup. Note that the relative assembly powers are much closer to prediction with the measured assembly powers generally 5.6% from predicted, coincident with an average percent difference of 2.4%. Figure 4.3 shows a map that was taken at the end of Cycle 2 life. The measured relative assembly powers were generally within 4.6% and the average percent difference was equal to 2.0%. Similar improvement was apparent in the measured quadrant power tilt ratio values for Cycle 2. The full-power tilt ratio (approximately 1.3%) that was reported in the Startup Physics Test Report[1] rapidly diminished with burnup accumulation to a value of approximately 0.6% at the end of Cycle 2. The radial power distributions were taken under equilibrium operating conditions with the unit at approximately full power.

An important aspect of core power distribution follow is the monitoring of nuclear hot channel factors. Verification that these factors are within Technical Specifications limits ensures that linear power density and critical heat flux limits will not be violated, thereby providing adequate thermal margins and maintaining fuel cladding integrity. The Cycle 2 Technical Specifications limit on the axially dependent heat flux hot channel factor, $F_Q(Z)$, began as 2.14 x K(Z), where K(Z) is the hot channel factor normalized operating envelope. Figure 4.4 is a plot of the K(Z) curve associated with the 2.14 $F_Q(Z)$ limit. On February 9, 1983, which corresponds to a Cycle 2 burnup of 6,559 MWD/MTU, the Technical Specifications $F_Q(Z)$ limit was changed to 2.20 (North Anna Unit 2 Technical Specifications Change No. 37[6]). Figure 4.5 is a plot of the K(Z) curve associated with the 2.20 $F_Q(Z)$ limit. The axially dependent heat flux hot channel factors, $F_Q(Z)$, for a representative set of flux maps are given in Figures 4.6 through 4.8. Throughout Cycle 2, the measured values of $F_Q(Z)$ were within the Technical Specifications limit. A summary of the maximum values of axially-dependent heat flux hot channel factors measured during Cycle 2 is given in Figure 4.9. Figure 4.10 shows the maximum values for the Heat Flux Hot Channel Factor measured during Cycle 2. As can be seen from the figure, there was an 18% margin to the limit at the beginning of the cycle, with the margin generally increasing throughout cycle operation.

The value of the enthalpy rise hot channel factor, F-delta H, which is the ratio of the integral of the power along the rod with the highest integrated power to that of the average rod, is routinely followed. The Technical Specifications limit for this parameter is set such that the critical heat flux (DNB) limit will not be violated. Additionally, the F-delta H limit ensures that the value of this parameter used in the LOCA-ECCS analysis is not exceeded during normal operation. The Cycle 2 limit on the enthalpy rise hot channel factor was set at 1.55 x (1+0.2(1-P)) x (1-RBP(BU)), where P is the fractional power level, and RBP(BU) is the rod bow penalty. A summary of the maximum values for the Enthalpy Rise Hot Channel Factor measured during Cycle 2 is given in Figure 4.11. As can be seen from this figure, there was a 8% margin to the limit at the beginning of the cycle, with the margin generally increasing throughout cycle operation.

The Technical Specifications require that target delta flux* values be determined periodically. The target delta flux is the delta flux which would occur at conditions of full power, all rods out, and equilibrium xenon. Therefore, the delta flux is measured with the core at or near these conditions and the target delta flux is established at this measured point. Since the target delta flux varies as a function of burnup, the target value is updated monthly. Operational delta flux limits are then

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$$\text{*Delta Flux} = \frac{Pt-Pb}{2775} \times 100$$

where Pt = power in top of core (MW(t))
Pb = power in bottom of core (MW(t))

established about this target value. By maintaining the value of delta flux relatively constant, adverse axial power shapes due to xenon redistribution are avoided. The plot of the target delta flux versus burnup, given in Figure 4.12, shows the value of this parameter to have been approximately 6% at the beginning of Cycle 2. After approximately one-third of the cycle, delta flux values had shifted to 0% and then moved to -4% by the end of Cycle 2. This power shift can also be observed in the corresponding core average axial power distribution for a representative series of maps given in Figures 4.13 through 4.15. In Map N2-2-16 (Figure 4.13), taken at approximately 1300 MWD/MTU, the axial power distribution had a shape peaked toward the top of the core with a peaking factor of 1.16. In Map N2-2-21 (Figure 4.14), taken at approximately 4,000 MWD/MTU, the axial power distribution had shifted toward the bottom of the core with an axial peaking factor of 1.12. Finally, in Map N2-2-30 (Figure 4.15), taken at approximately 8,000 MWD/MTU, the axial peaking factor was 1.14. The history of F-Z during the cycle can be scen more clearly in a plot of F-Z versus burnup given in Figure 4.16.

In conclusion, the North Anna 2, Cycle 2 core performed satisfactorily with power distribution analyses verifying that design predictions were accurate and that the values of the $F_Q(Z)$ and F-delta H hot channel factors were within the limits of the Technical Specifications.

TABLE 4.1

NORTH ANNA UNIT 2 - CYCLE 2

SUMMARY OF INCORE FLUX MAPS FOR ROUTINE OPERATION

MAP NO.	DATE	BURNUP MWD/MTU	PWR (%)	BANK D STEPS	F-Q(T) HOT CHANNEL FACTOR[1]				F-DH(N) HOT CHNL. FACTOR[2]			CORE F(Z) MAX		F(XY) MAX[3]	QPTR[4]		AXIAL OFF SET (%)	NO. OF THIMBLES
					ASSY	PIN	AXIAL POINT	F-Q(T)	ASSY	PIN	F-DH(N)	AXIAL POINT	F(Z)		MAX	LOC		
10	6-22-82	251	100	228	H12	MO	12	1.742	K14	MN	1.409	12	1.197	1.605	1.013	SE	5.29	45
12 (5)	6-23-82	300	94	228	K14	MN	36	1.734	K14	MN	1.433	12	1.189	1.643	1.014	SE	4.47	40
13	6-24-82	307	99	222	K14	MN	37	1.714	K14	MN	1.407	12	1.164	1.600	1.013	SE	3.19	43
14	6-25-82	325	100	218	K14	MN	45	1.735	K14	MN	1.411	13	1.146	1.602	1.013	SE	1.81	45
16 (6)	9-14-82	1295	98	220	K14	MN	37	1.737	K14	MN	1.429	12	1.162	1.618	1.012	SE	3.40	49
17	9-27-82	1700	100	223	K14	MN	38	1.745	K14	MN	1.432	12	1.129	1.617	1.010	SE	1.41	50
18	10- 4-82	1995	100	216	K14	MN	46	1.779	K14	MN	1.430	47	1.110	1.609	1.009	SE	-0.77	50
19	10-15-82	2427	100	222	K14	MN	46	1.745	K14	MN	1.417	12	1.111	1.601	1.009	SE	0.06	49
20	11- 5-82	3225	100	224	K14	MN	46	1.739	K14	MN	1.416	47	1.104	1.585	1.007	SE	-0.60	50

NOTES: HOT SPOT LOCATIONS ARE SPECIFIED BY GIVING ASSEMBLY LOCATIONS (E.G. H-8 IS THE CENTER-OF-CORE ASSEMBLY), FOLLOWED BY THE PIN LOCATION (DENOTED BY THE "Y" COORDINATE WITH THE SEVENTEEN ROWS OF FUEL RODS LETTERED A THROUGH R AND THE "X" COORDINATE DESIGNATED IN A SIMILAR MANNER). IN THE "Z" DIRECTION THE CORE IS DIVIDED INTO 61 AXIAL POINTS STARTING FROM THE TOP OF THE CORE.

1. F-Q(T) INCLUDES A TOTAL UNCERTAINTY OF 1.05 X 1.03

2. F-DH(N) INCLUDES A MEASUREMENT UNCERTAINTY OF 1.04

3. F(XY) INCLUDES A TOTAL UNCERTAINTY OF 1.05 X 1.03.

4. QPTR - QUADRANT POWER TILT RATIO.

5. MAP 11 WAS A QUARTER-CORE MAP TAKEN FOR INCORE/EXCORE DETECTOR CALIBRATION.

6. MAP 15 WAS A QUARTER-CORE MAP TAKEN FOR INCORE/EXCORE DETECTOR CALIBRATION.

TABLE 4.1 (CONT.)

MAP NO.	DATE	BURN UP MWD/MTU	PWR (%)	BANK D STEPS	F-Q(T) HOT CHANNEL FACTOR				F-DH(N) HOT CHNL.FACTOR			CORE F(Z) MAX		F(XY) MAX	QPTR		AXIAL OFF SET (%)	NO. OF THIMBLES
					ASSY	PIN	AXIAL POINT	F-Q(T)	ASSY	PIN	F-DH(N)	AXIAL POINT	F(Z)		MAX	LOC		
21	11-29-82	4110	100	228	K14	MN	46	1.735	K14	MN	1.402	47	1.121	1.556	1.006	SE	-2.12	50
24 (7)	12-13-82	4599	100	224	K14	MN	47	1.723	K14	MN	1.397	47	1.119	1.551	1.006	SE	-2.20	47
25	1-12-83	5564	100	227	K14	MN	47	1.728	K14	MN	1.382	53	1.149	1.523	1.005	SW	-3.93	50
27 (8)	2-15-83	6750	100	218	K14	MN	46	1.683	K14	MN	1.369	53	1.145	1.496	1.006	SW	-3.95	50
30 (9)	3-17-83	7844	100	218	K14	MN	46	1.647	K14	MN	1.355	53	1.142	1.464	1.006	SW	-3.95	50

7. MAPS 22 AND 23 WERE QUARTER-CORE MAPS TAKEN FOR INCORE/EXCORE DETECTOR CALIBRATION.

8. MAP 26 WAS A QUARTER-CORE MAP TAKEN TO DETERMINE AN APPROXIMATE VALUE OF INCORE AXIAL OFFSET.

9. MAPS 28 AND 29 1WERE QUARTER-CORE MAPS TAKEN FOR INCORE/EXCORE DETECTOR CALIBRATION.

Figure 4.1

NORTH ANNA UNIT 2 - CYCLE 2

ASSEMBLYWISE POWER DISTRIBUTION N2-2-16

MEASURED / PCT DIFFERENCE

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.72	0.88	0.71						
							4.5	4.6	3.9						
2					0.71	1.01	1.14	0.90	1.14	1.02	0.72				
					2.8	1.3	1.8	1.8	2.5	3.2	4.4				
3				0.76	1.07	0.96	0.93	0.94	0.93	0.95	1.07	0.78			
				2.2	2.1	1.4	-0.7	-0.8	-0.7	0.4	2.3	5.7			
4			0.75	1.01	0.96	1.20	1.14	1.17	1.13	1.19	0.96	1.02	0.77		
			1.6	0.9	1.0	-0.6	-1.7	-1.8	-2.1	-1.6	1.0	2.2	3.6		
5		0.70	1.05	0.94	0.90	1.14	1.13	1.02	1.13	1.14	0.90	0.95	1.06	0.71	
		0.5	0.5	-0.6	-1.0	-1.9	-4.0	-4.6	-3.5	-2.3	-1.3	0.5	1.4	2.8	
6		0.99	0.95	1.20	1.14	0.97	1.05	0.95	1.05	0.97	1.15	1.20	0.95	1.02	
		0.0	0.0	-1.1	-2.3	-3.6	-4.7	-4.8	-4.5	-3.4	-1.5	-0.6	0.5	2.8	
7	0.72	1.12	0.92	1.13	1.13	1.05	0.98	1.16	0.90	1.04	1.11	1.15	0.96	1.16	0.72
	5.2	0.6	-1.6	-2.9	-4.2	-4.7	-4.9	-5.0	-5.6	-6.1	-5.1	-0.6	2.1	3.8	4.6
8	0.89	0.89	0.93	1.14	1.00	0.94	1.15	0.92	1.14	0.94	1.00	1.18	0.97	0.94	0.90
	5.2	0.6	-1.7	-3.7	-5.7	-5.7	-5.6	-5.2	-4.3	-4.5	-4.0	-0.3	2.2	5.6	6.9
9	0.72	1.13	0.94	1.12	1.11	1.04	0.97	1.15	0.97	1.03	1.11	1.16	0.97	1.18	0.74
	5.2	1.6	-0.3	-3.1	-5.8	-5.8	-5.8	-5.2	-4.5	-4.6	-5.4	0.5	3.1	6.3	7.8
10		1.02	0.97	1.19	1.12	0.96	1.06	0.96	1.06	0.97	1.14	1.21	0.97	1.07	
		2.3	2.3	-1.8	-4.0	-4.7	-4.4	-4.4	-4.1	-3.4	-2.4	-0.4	1.9	7.7	
11		0.71	1.08	0.96	0.97	1.13	1.14	1.03	1.14	1.15	0.90	0.97	1.08	0.73	
		3.0	3.0	1.5	-1.4	-2.9	-3.4	-3.3	-2.8	-1.3	-0.4	2.0	3.3	6.1	
12			0.77	1.01	0.94	1.19	1.15	1.10	1.16	1.22	0.96	1.03	0.77		
			3.7	1.2	-1.4	-1.6	-0.9	-0.8	0.5	1.1	1.2	3.1	4.7		
13				0.78	1.12	0.90	0.94	0.96	0.98	1.00	1.08	0.77			
				5.7	7.6	3.0	0.1	1.7	4.1	5.2	3.7	4.4			
14					0.75	1.09	1.19	0.94	1.16	1.04	0.73				
					7.6	9.5	6.9	6.1	4.1	5.2	5.6				
15							0.76	0.91	0.72						
							11.7	8.4	4.0						

MEASURED / PCT DIFFERENCE

STANDARD DEVIATION = 2.222

AVERAGE PCT. DIFFERENCE = 3.3

SUMMARY

MAP NO: N2-2-16

DATE: 9/14/82

POWER: 98%

CONTROL ROD POSITIONS: D BANK AT 220 STEPS

F-Q(T) = 1.737

F-DH(N) = 1.429

F(Z) = 1.162

F(XY) = 1.618

BURNUP = 1295 MWD/MTU

A.O = 3.40(%)

QPTR:

NW 0.989	NE 0.999
SW 1.000	SE 1.012

Figure 4.2

NORTH ANNA UNIT 2 - CYCLE 2
ASSEMBLYWISE POWER DISTRIBUTION N2-2-21

MEASURED / PCT DIFFERENCE

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.73	0.90	0.73						
							3.5	3.5	2.7						
2					0.74	1.01	1.16	0.92	1.16	1.02	0.74				
					3.5	0.9	1.2	1.2	1.5	1.0	3.4				
3				0.70	1.11	0.97	0.93	0.94	0.93	0.96	1.10	0.80			
				2.0	2.7	1.4	-1.1	-1.3	-1.1	0.1	1.0	5.2			
4			0.77	1.02	0.97	1.10	1.11	1.13	1.10	1.17	0.96	1.03	0.79		
			1.3	1.2	1.7	-0.1	-1.0	-1.9	-2.2	-1.2	0.9	1.0	3.2		
5		0.71	1.07	0.95	0.96	1.12	1.10	1.00	1.11	1.12	0.97	0.95	1.11	0.74	
		-0.8	-0.8	-0.4	-0.3	-1.0	-3.4	-3.4	-2.6	-1.4	-0.8	0.1	2.3	3.7	
6		1.01	0.95	1.10	1.12	0.97	1.04	0.96	1.07	0.90	1.12	1.10	0.94	1.02	
		-0.8	-0.0	-0.8	-1.5	-2.4	-3.3	-3.2	-2.7	-1.9	-1.0	-0.7	0.5	1.7	
7	0.73	1.15	0.94	1.10	1.10	1.06	0.98	1.15	0.90	1.05	1.09	1.12	0.95	1.16	0.72
	3.1	0.3	-0.9	-2.0	-3.1	-3.3	-3.3	-3.2	-3.9	-4.2	-3.9	-0.8	0.6	1.5	1.0
8	0.90	0.91	0.94	1.12	0.99	0.95	1.14	0.93	1.13	0.94	0.99	1.15	0.96	0.94	0.90
	3.1	0.3	-1.2	-2.8	-4.4	-4.2	-3.6	-3.1	-4.5	-4.7	-4.9	-0.6	0.7	3.1	3.9
9	0.73	1.15	0.94	1.10	1.09	1.05	0.96	1.14	0.97	1.04	1.09	1.13	0.96	1.19	0.74
	3.1	0.9	-0.2	-2.4	-4.6	-4.8	-5.3	-4.1	-4.9	-5.1	-4.3	0.2	1.7	3.0	4.9
10		1.03	0.90	1.17	1.10	0.96	1.05	0.95	1.06	0.97	1.11	1.10	0.96	1.05	
		2.5	2.5	-1.0	-2.8	-3.7	-4.2	-3.7	-3.3	-2.6	-1.9	-0.1	1.0	4.8	
11		0.74	1.12	0.97	0.90	1.11	1.10	1.01	1.11	1.12	0.98	0.97	1.10	0.74	
		3.2	3.2	2.0	-0.3	-2.3	-3.2	-3.2	-2.9	-1.4	-0.4	1.4	2.0	3.4	
12			0.79	1.03	0.95	1.17	1.12	1.14	1.13	1.19	0.96	1.03	0.79		
			3.9	1.9	-0.3	-0.9	-1.1	-1.1	-0.1	0.5	0.8	2.1	3.0		
13				0.80	1.15	0.90	0.94	0.96	0.96	0.98	1.11	0.78			
				5.2	6.5	2.5	-0.2	0.4	2.2	2.9	2.8	2.9			
14					0.76	1.08	1.20	0.94	1.17	1.03	0.75				
					6.5	7.5	5.0	3.6	2.2	2.7	4.1				
15							0.77	0.91	0.72						
							0.2	5.0	1.3						

STANDARD DEVIATION = 1.635

AVERAGE PCT. DIFFERENCE = 2.4

SUMMARY

MAP NO: N2-2-21

CONTROL ROD POSITIONS:

D BANK AT 228 STEPS

DATE: 11/29/82

F-Q(T) = 1.735

F-DH(N) = 1.402

F(Z) = 1.121

F(XY) = 1.556

BURNUP = 4110 MWD/MTU   A.O = -2.12(%)

POWER: 100%

QPTR:

NW 0.993	NE 0.999
SW 1.002	SE 1.006

Figure 4.3

NORTH ANNA UNIT 2 - CYCLE 2

ASSEMBLYWISE POWER DISTRIBUTION N2-2-30

MEASURED / PCT DIFFERENCE

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.73	0.80	0.72						
							2.7	2.7	1.0						
2					0.74	1.00	1.15	0.91	1.15	1.00	0.74				
					1.9	1.1	1.0	0.9	0.9	0.0	2.7				
3				0.79	1.13	0.97	0.94	0.95	0.94	0.95	1.12	0.81			
				1.0	1.0	1.5	-0.8	-1.0	-1.3	-0.5	1.2	4.6			
4			0.78	1.02	0.97	1.16	1.09	1.12	1.09	1.15	0.97	1.03	0.80		
			0.4	0.7	1.3	-0.1	-1.6	-1.7	-2.0	-1.3	0.0	1.0	3.1		
5		0.72	1.10	0.96	0.90	1.11	1.09	1.01	1.10	1.11	0.90	0.97	1.13	0.75	
		-0.9	-0.9	-0.4	-0.2	-1.0	-2.6	-2.0	-2.0	-1.3	-0.6	0.4	2.4	3.7	
6		0.99	0.96	1.16	1.11	0.90	1.10	0.90	1.10	0.90	1.11	1.16	0.96	1.01	
		0.1	0.1	-0.5	-1.3	-2.0	-2.4	-2.3	-1.7	-1.5	-0.8	-0.6	0.4	1.5	
7	0.72	1.14	0.94	1.09	1.10	1.09	1.01	1.16	1.01	1.09	1.09	1.09	0.95	1.15	0.72
	2.5	0.5	-0.4	-1.6	-2.8	-2.6	-1.9	-1.9	-2.6	-3.0	-3.1	-1.4	0.0	0.8	1.4
8	0.80	0.91	0.95	1.11	1.00	0.97	1.16	0.96	1.15	0.97	0.99	1.12	0.96	0.93	0.80
	2.4	0.4	-0.6	-2.1	-3.6	-3.1	-2.1	-1.8	-3.1	-3.3	-4.0	-1.3	0.1	2.1	3.1
9	0.72	1.15	0.95	1.09	1.06	1.00	1.00	1.16	1.00	1.08	1.08	1.10	0.95	1.17	0.73
	2.5	1.1	0.5	-1.6	-3.7	-3.6	-3.3	-2.2	-3.3	-5.5	-3.9	-1.3	0.6	2.7	3.9
10		1.02	0.99	1.16	1.10	0.97	1.09	0.90	1.09	0.90	1.10	1.15	0.95	1.02	
		3.0	3.0	-0.4	-2.3	-2.7	-3.1	-2.5	-2.7	-2.2	-2.2	-1.3	-0.5	3.4	
11		0.75	1.15	0.90	0.90	1.10	1.10	1.01	1.09	1.10	0.90	0.97	1.12	0.74	
		3.6	3.6	2.2	-0.5	-2.6	-2.5	-2.5	-2.9	-1.7	-0.9	0.9	1.3	2.7	
12			0.81	1.03	0.96	1.16	1.09	1.12	1.10	1.17	0.97	1.03	0.80		
			4.3	2.0	-0.5	-0.8	-1.4	-1.4	-0.6	0.2	0.6	2.0	3.1		
13				0.81	1.17	0.90	0.94	0.96	0.96	0.90	1.14	0.80			
				5.1	5.9	2.4	-0.7	-0.2	1.4	2.4	2.7	3.0			
14					0.77	1.06	1.10	0.93	1.15	1.01	0.75				
					5.9	6.6	3.7	2.6	1.4	2.2	3.6				
15							0.76	0.89	0.71						
							7.3	4.2	0.9						

STANDARD DEVIATION = 1.334

AVERAGE PCT. DIFFERENCE = 2.0

SUMMARY

MAP NO: N2-2-30 DATE: 3/17/83 POWER: 100%

CONTROL ROD POSITIONS: F-Q(T) = 1.647 QPTR:

D BANK AT 218 STEPS F-DH(N) = 1.355

NW 0.998	NE 0.997
SW 1.006	SE 0.999

F(Z) = 1.142

F(XY) = 1.464

BURNUP = 7844 MWD/MTU A.O = -3.95(%)

Figure 4.4

HOT CHANNEL FACTOR NORMALIZED
OPERATING ENVELOPE
FOR A $F_Q(Z)$ LIMIT OF 2.14

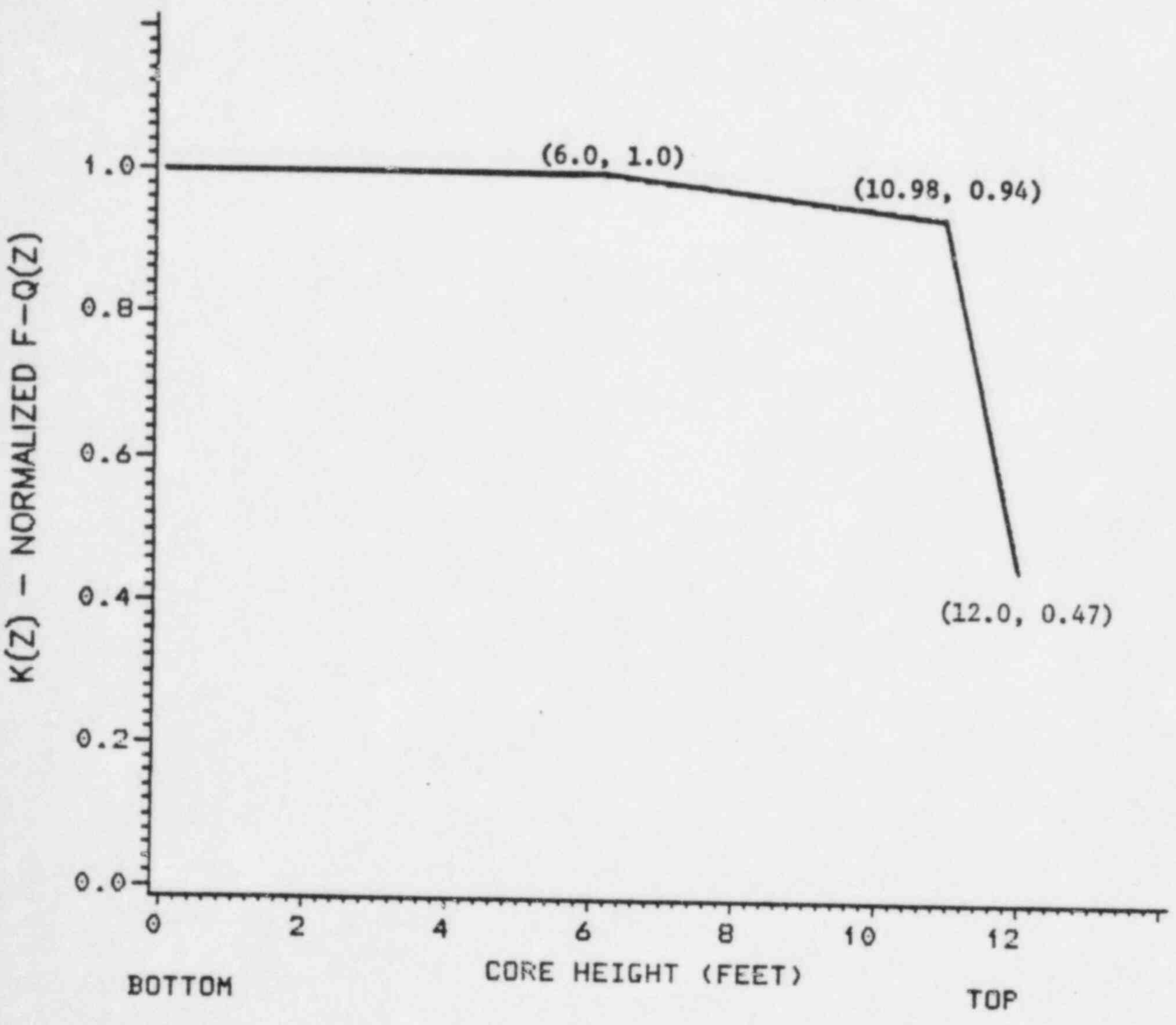


Figure 4.5

HOT CHANNEL FACTOR NORMALIZED

OPERATING ENVELOPE

FOR A $F_Q(Z)$ LIMIT OF 2.20

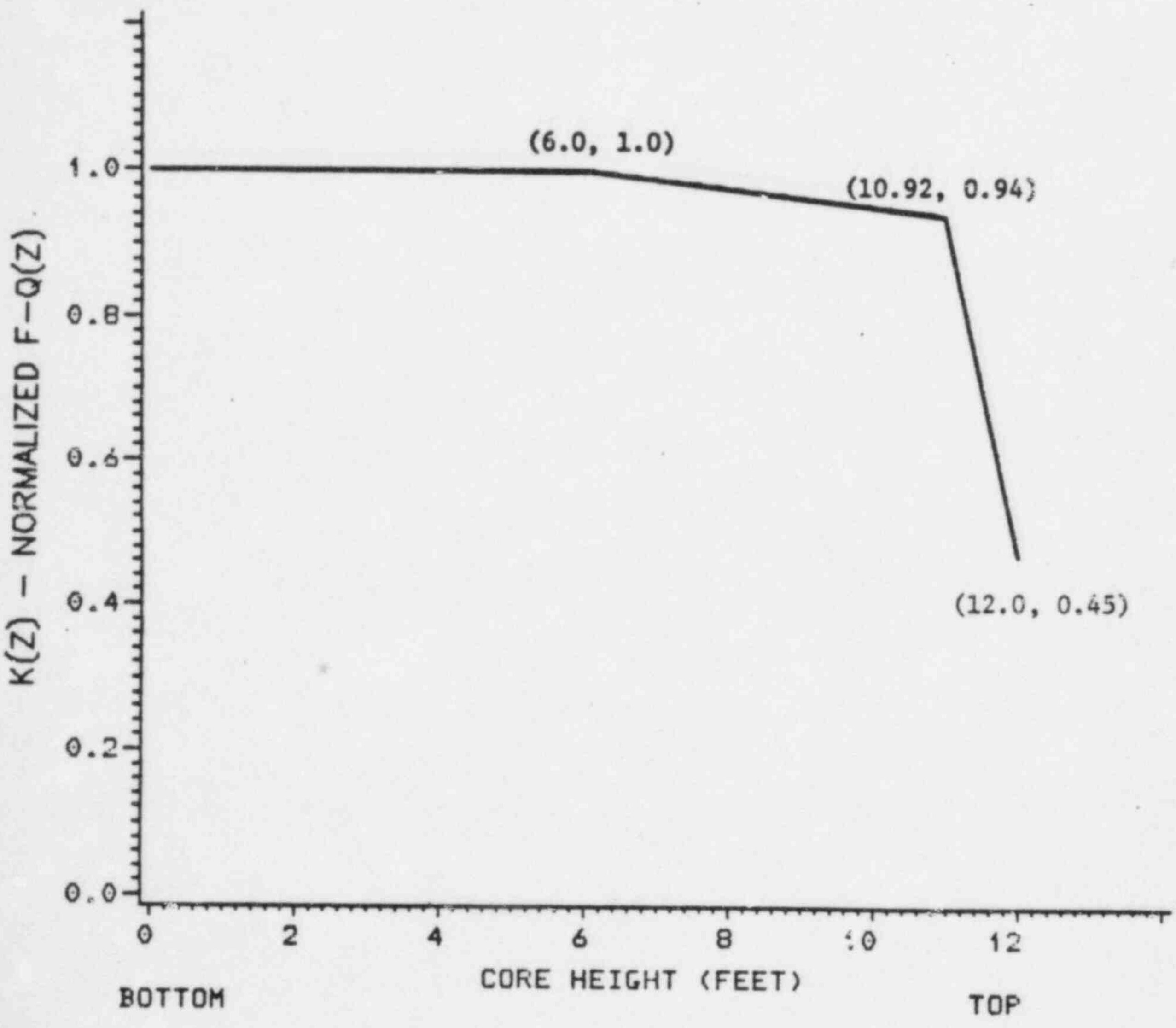


Figure 4.6

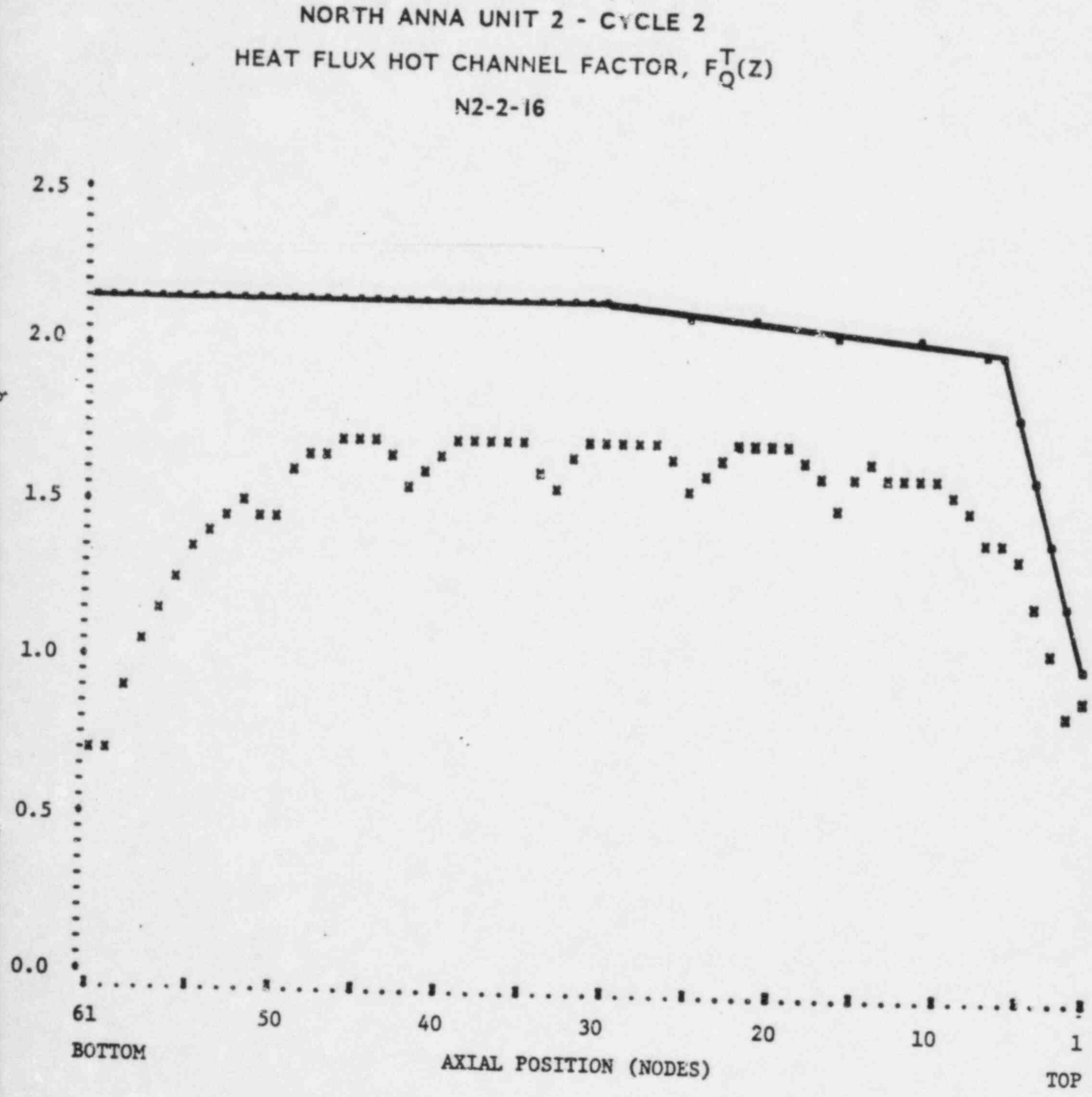

NORTH ANNA UNIT 2 - CYCLE 2
HEAT FLUX HOT CHANNEL FACTOR, $F_Q^T(Z)$
N2-2-16
2.5
2.0
1.5
1.0
0.5
0.0
61
BOTTOM
50
40
30
20
10
1
TOP
AXIAL POSITION (NODES)

Figure 4.7

NORTH ANNA UNIT 2 - CYCLE 2

HEAT FLUX HOT CHANNEL FACTOR, $F_Q^T(Z)$

N2-2-21

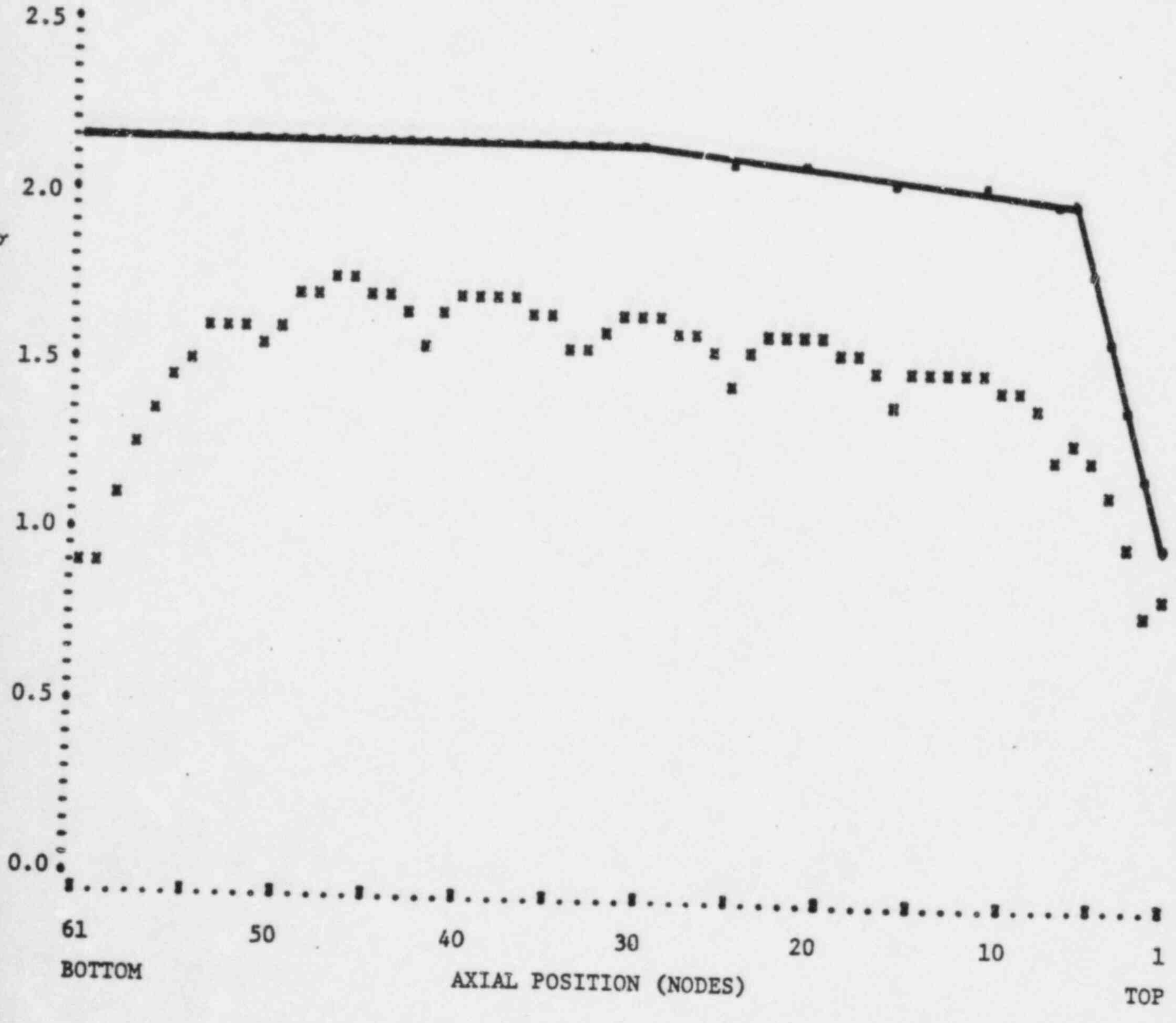


Figure 4.8

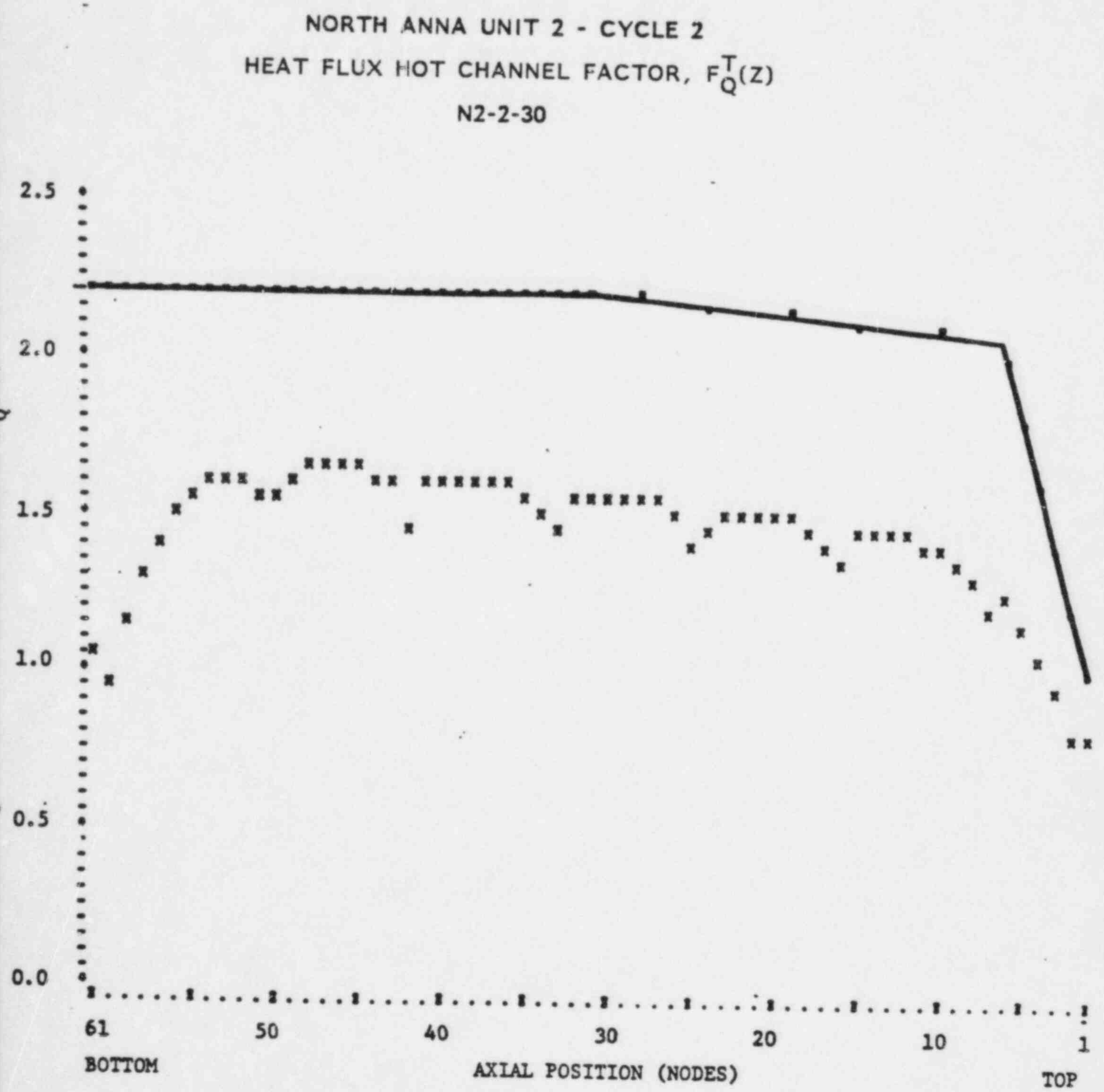

NORTH ANNA UNIT 2 - CYCLE 2
HEAT FLUX HOT CHANNEL FACTOR, $F_Q^T(Z)$
N2-2-30
2.5
2.0
1.5
1.0
0.5
0.0
61
50
40
30
20
10
1
BOTTOM
AXIAL POSITION (NODES)
TOP

Figure 4.9

NORTH ANNA UNIT 2 - CYCLE 2

MAXIMUM HEAT FLUX HOT CHANNEL FACTOR, FQ * P VS AXIAL POSITION

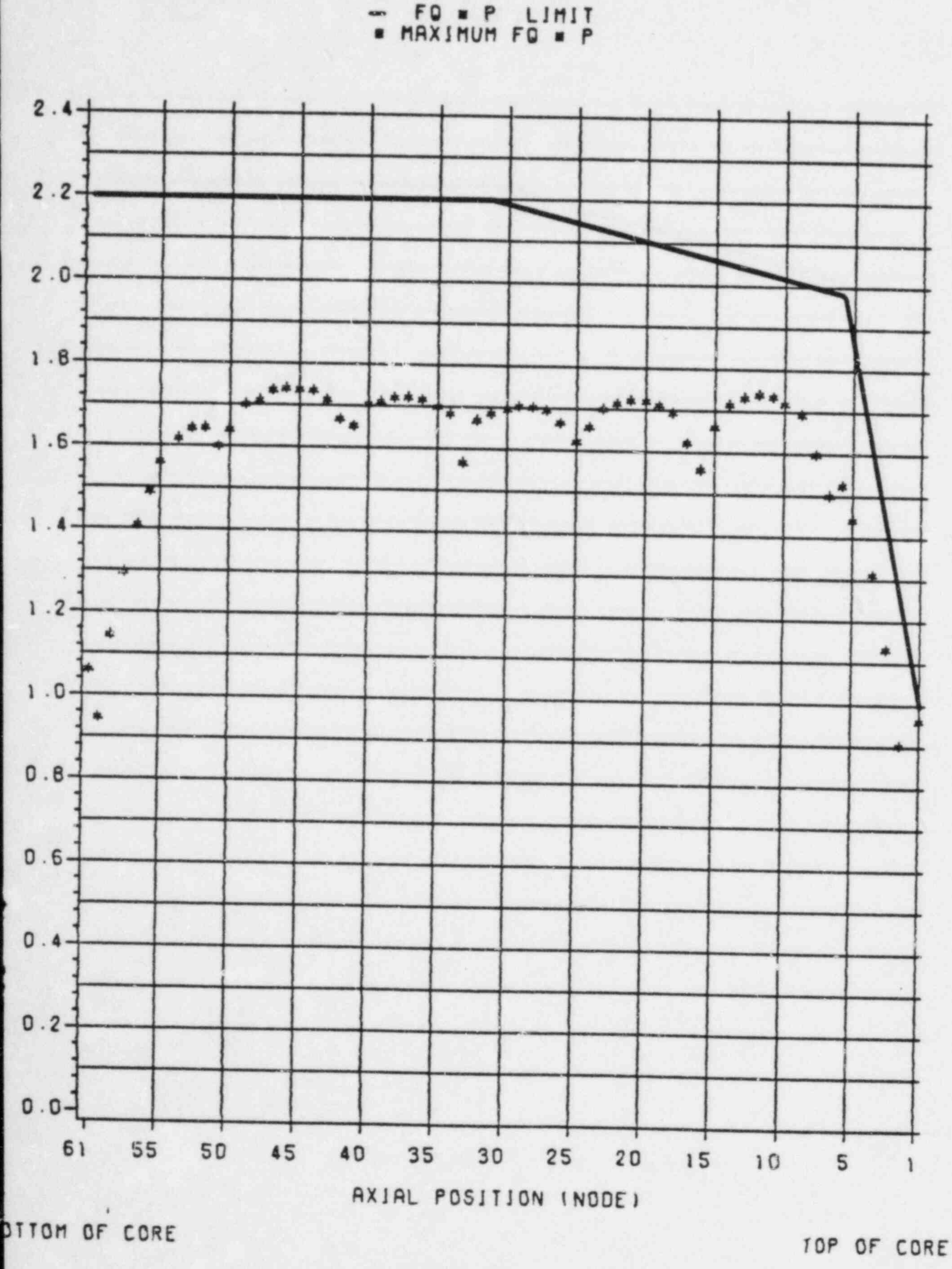


Figure 4.10

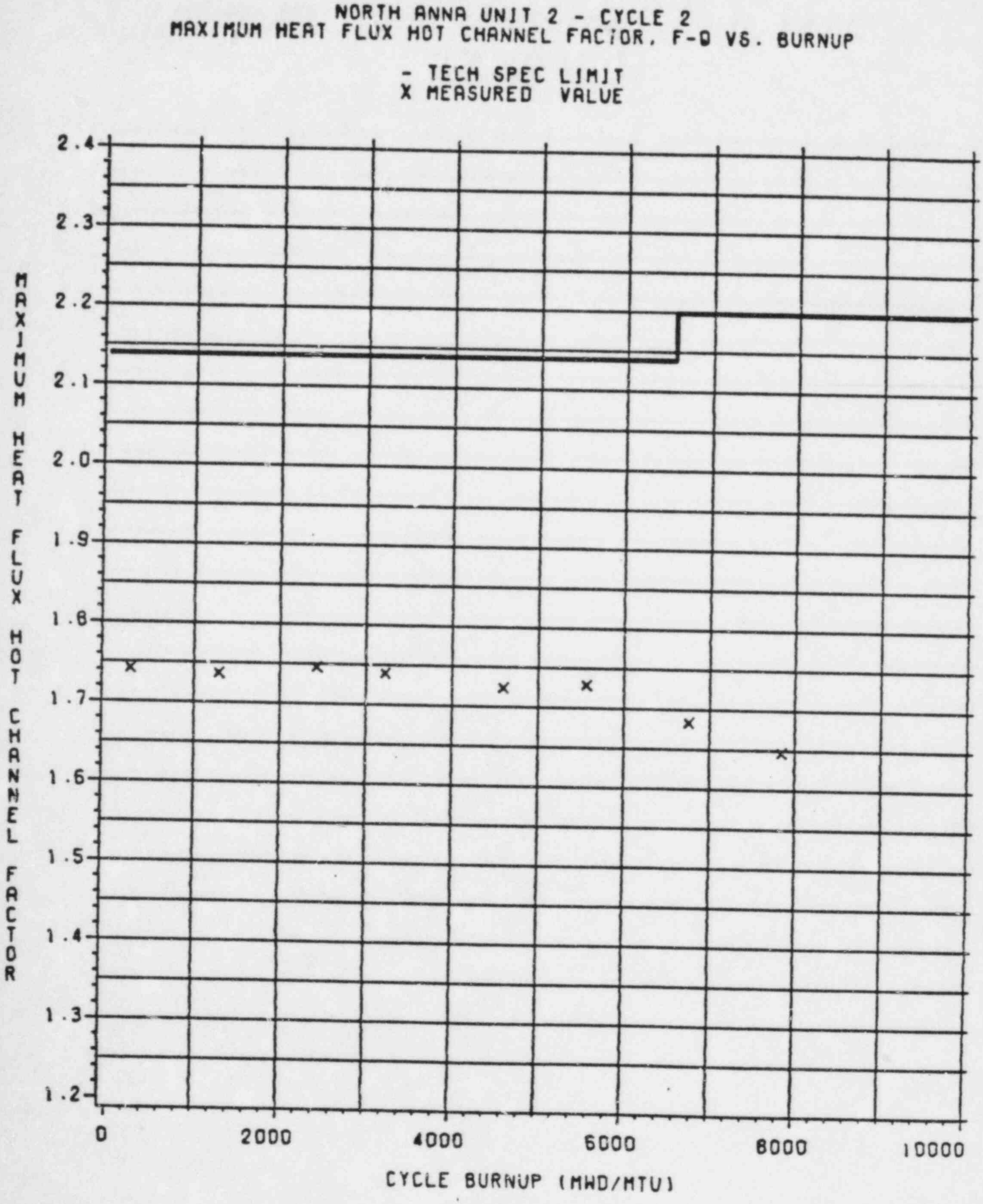

NORTH ANNA UNIT 2 - CYCLE 2
MAXIMUM HEAT FLUX HOT CHANNEL FACTOR, F-Q VS. BURNUP
- TECH SPEC LIMIT
X MEASURED VALUE
MAXIMUM HEAT FLUX HOT CHANNEL FACTOR
2.4
2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
0
2000
4000
6000
8000
10000
CYCLE BURNUP (MWD/MTU)

Figure 4.11

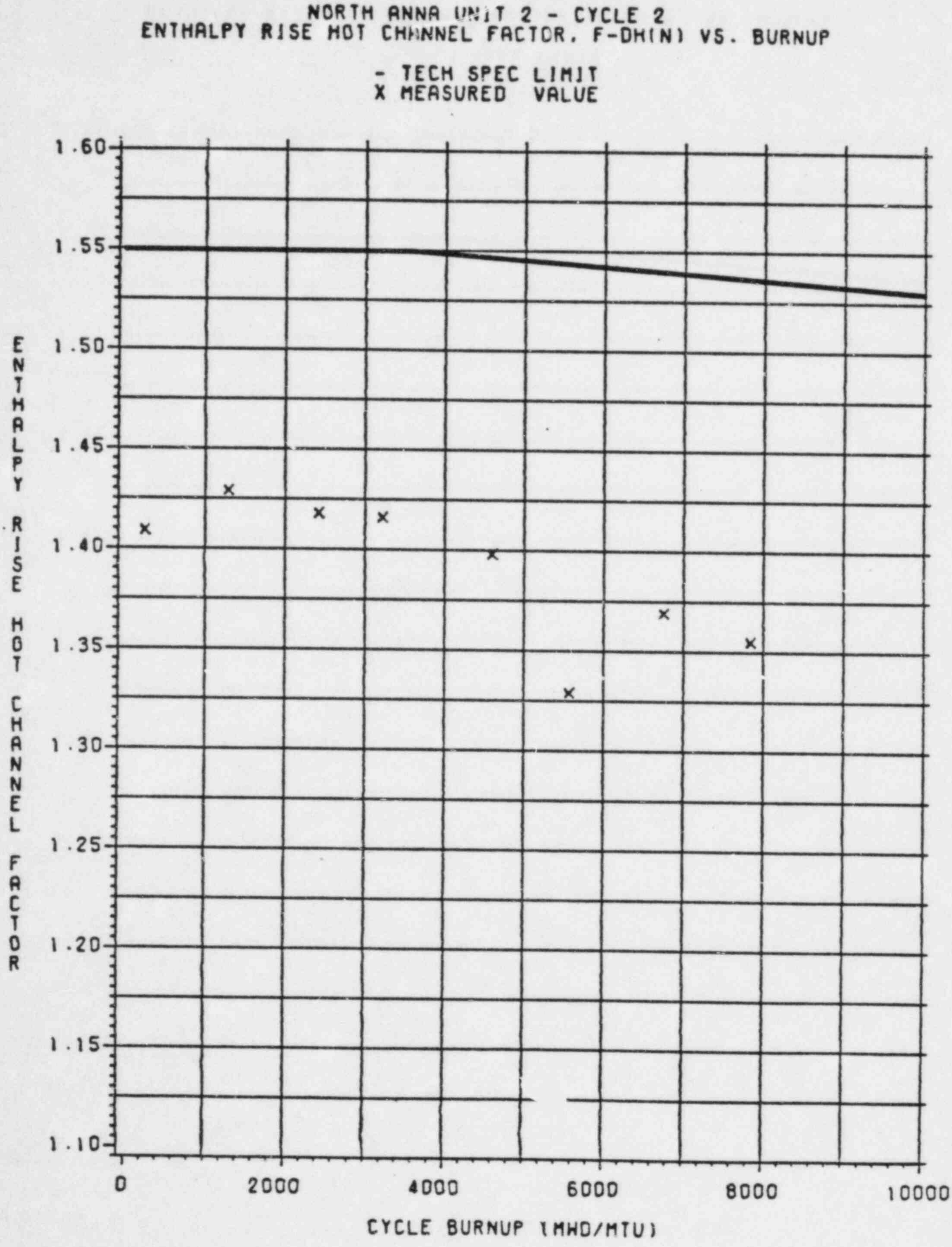

NORTH ANNA UNIT 2 - CYCLE 2
ENTHALPY RISE HOT CHANNEL FACTOR, F-DH(N) VS. BURNUP
- TECH SPEC LIMIT
X MEASURED VALUE
ENTHALPY RISE HOT CHANNEL FACTOR
1.60
1.55
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
0
2000
4000
6000
8000
10000
CYCLE BURNUP (MWD/MTU)

Figure 4.12

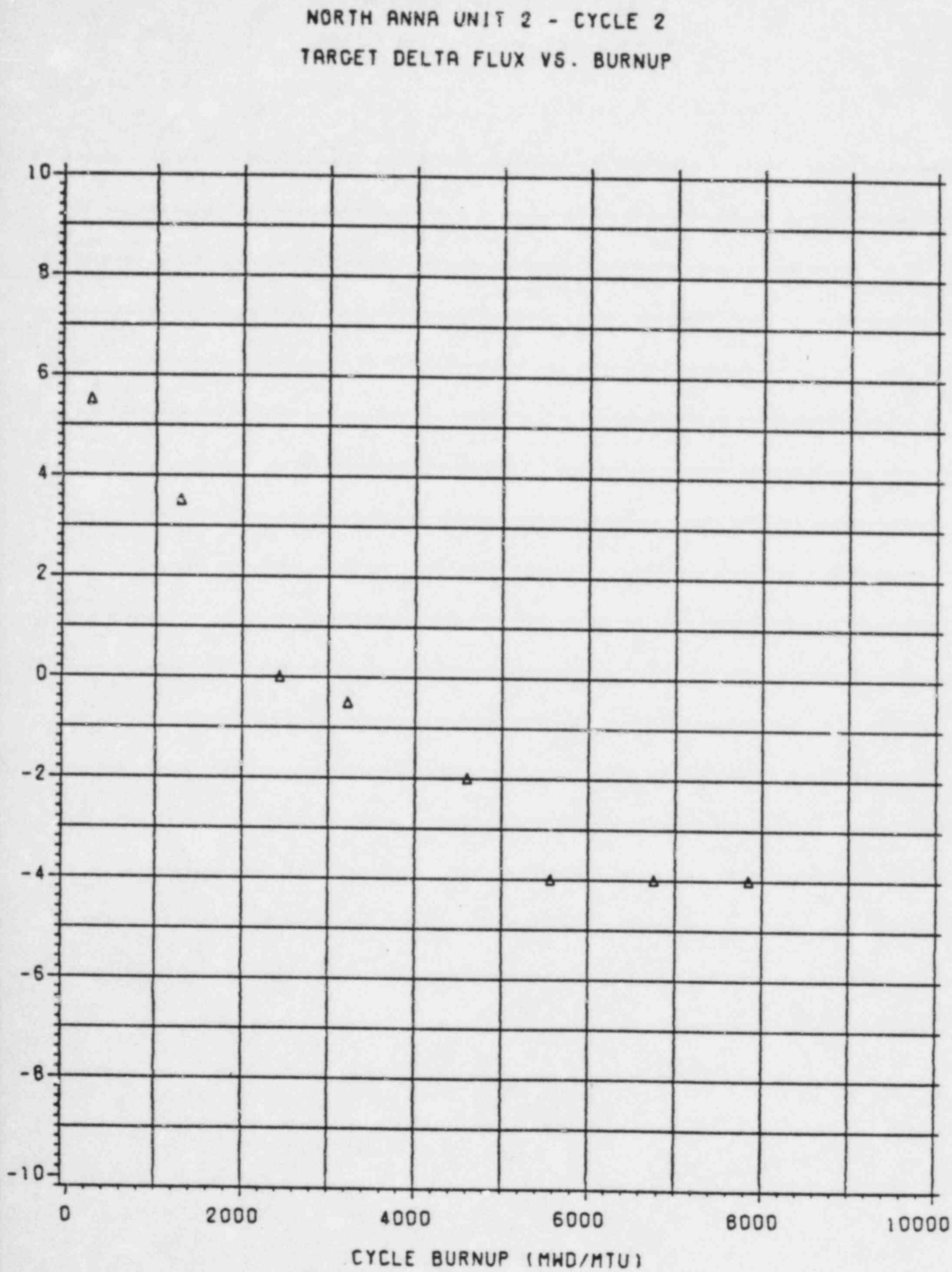

NORTH ANNA UNIT 2 - CYCLE 2
TARGET DELTA FLUX VS. BURNUP
10
8
6
4
2
0
-2
-4
-6
-8
-10
0
2000
4000
6000
8000
10000
CYCLE BURNUP (MWD/MTU)

Figure 4.13

NORTH ANNA UNIT 2 - CYCLE 2

CORE AVERAGE AXIAL POWER DISTRIBUTION

N2-2-16

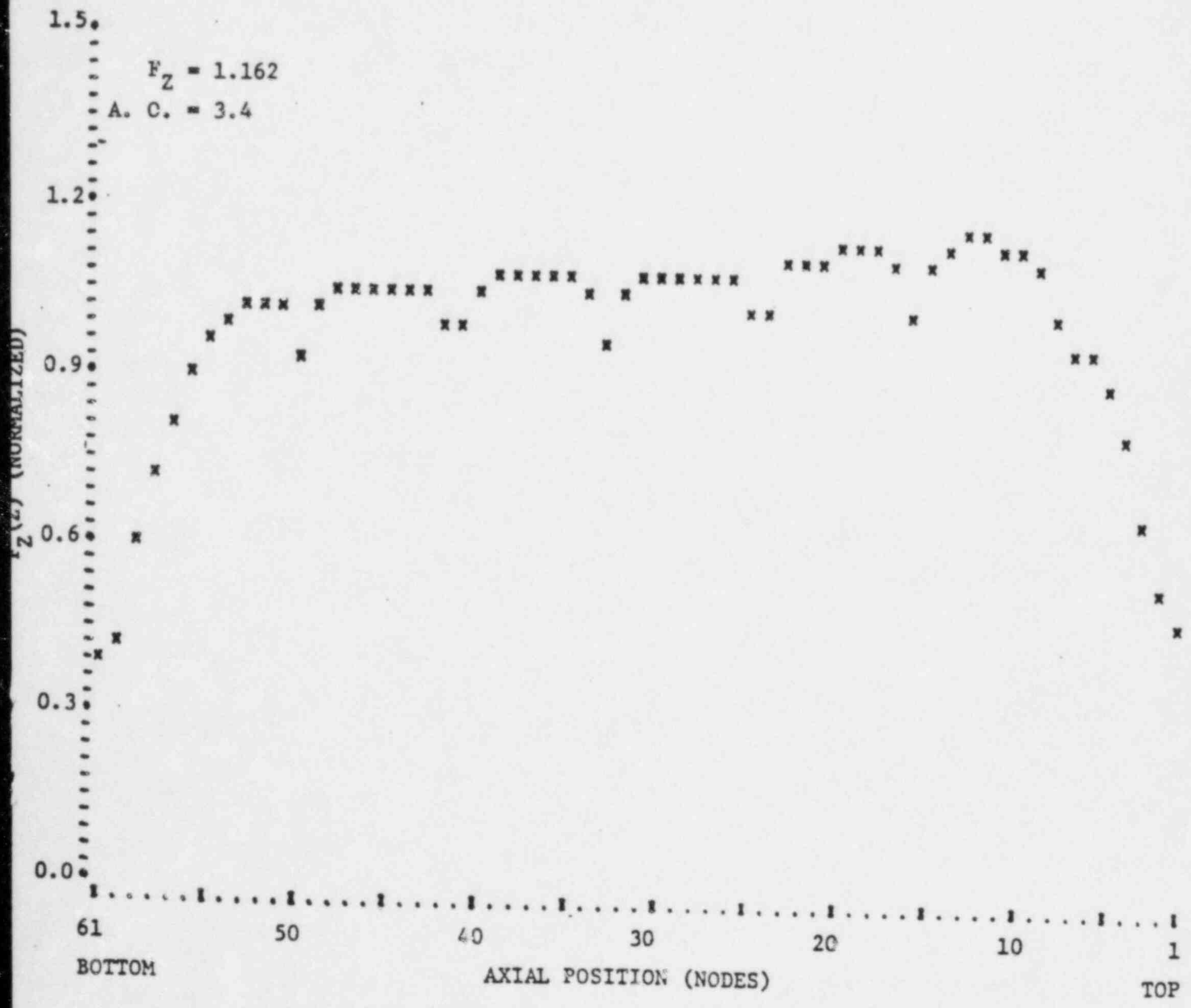
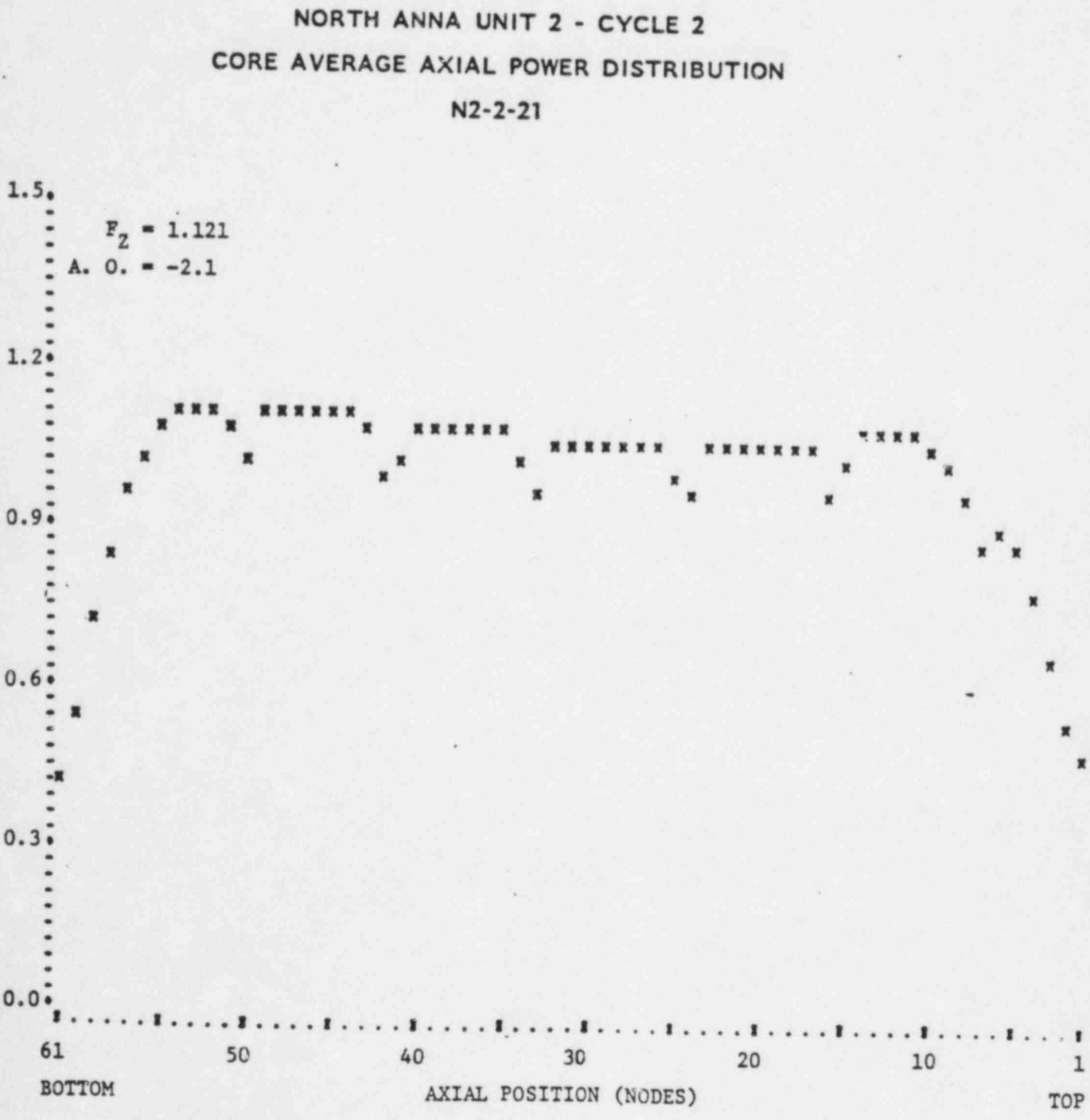


Figure 4.14



NORTH ANNA UNIT 2 - CYCLE 2
CORE AVERAGE AXIAL POWER DISTRIBUTION
N2-2-21
1.5
1.2
0.9
0.6
0.3
0.0
F_Z = 1.121
A. O. = -2.1
$F_Z(Z)$ (NORMALIZED)
61
50
40
30
20
10
1
BOTTOM
AXIAL POSITION (NODES)
TOP

Figure 4.15

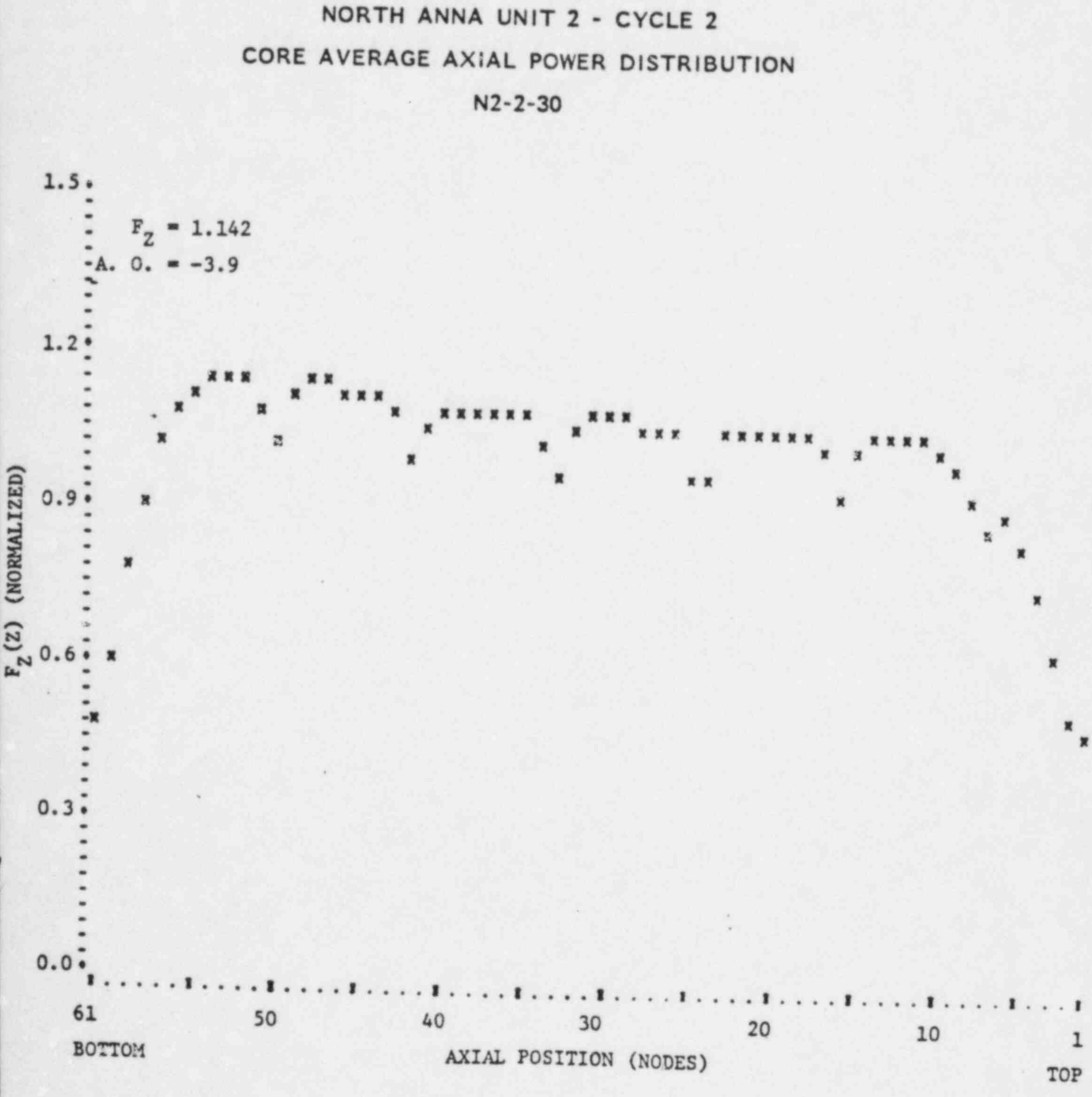
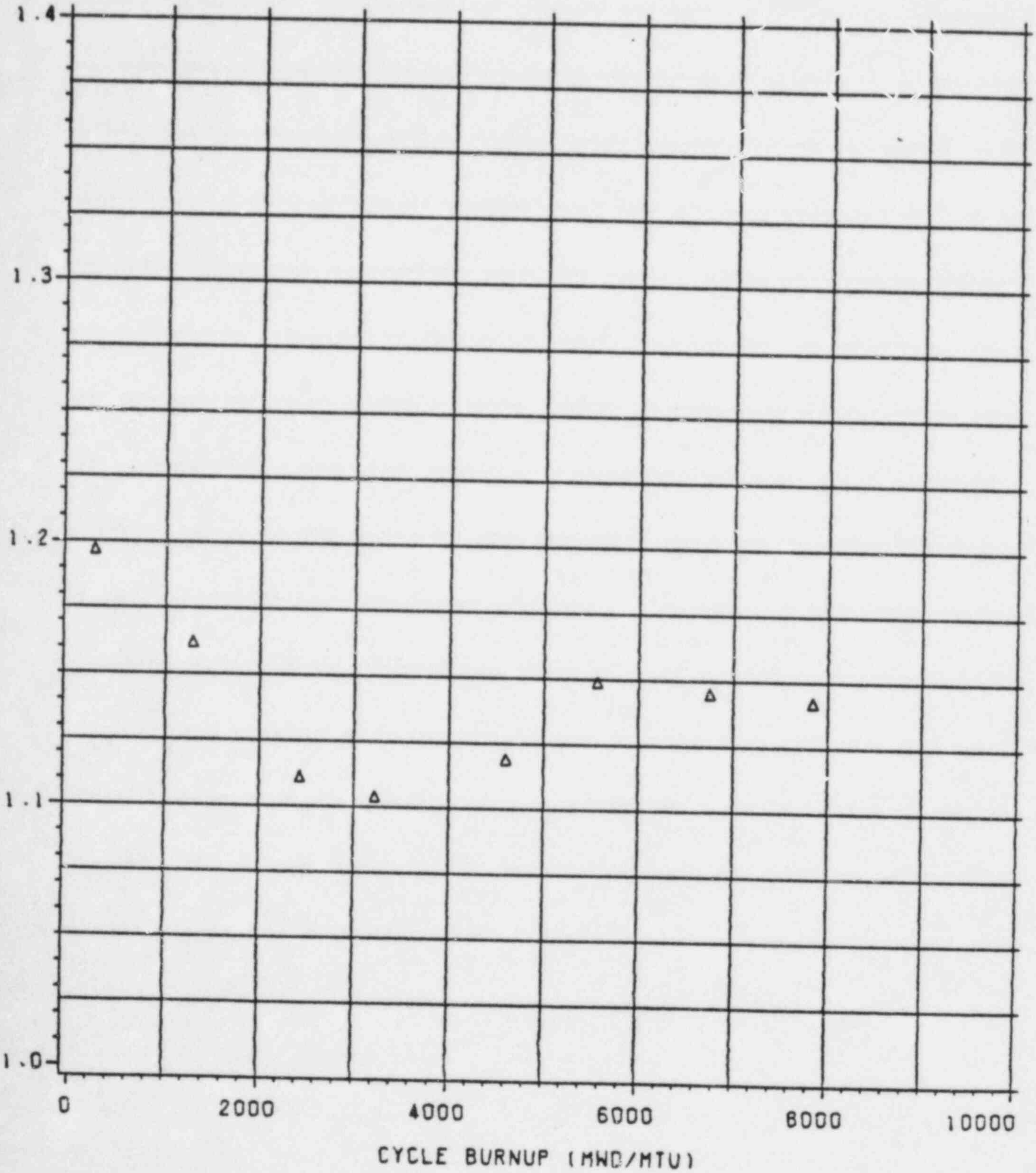

NORTH ANNA UNIT 2 - CYCLE 2
CORE AVERAGE AXIAL POWER DISTRIBUTION
N2-2-30
F_Z = 1.142
A. O. = -3.9
$F_Z(Z)$ (NORMALIZED)
1.5
1.2
0.9
0.6
0.3
0.0
61
BOTTOM
50
40
30
20
10
1
TOP
AXIAL POSITION (NODES)

Figure 4.16

NORTH ANNA UNIT 2 - CYCLE 2

CORE AVERAGE AXIAL PEAKING FACTOR, F-Z VS. BURNUP



Section 5

PRIMARY COOLANT ACTIVITY FOLLOW

Activity levels of iodine-131 and 133 in the primary coolant are important in core performance follow analysis because they are used as indicators of defective fuel. Additionally, they are also important with respect to the offsite dose calculation values associated with accident analyses. Both I-131 and I-133 can leak into the primary coolant system throught a breach in the cladding. As indicated in the North Anna 2 Technical Specifications, the dose equivalent I-131 concentration in the primary coolant was limited to 1.0 µCi/gm for normal steady state operation. Figure 5.1 shows the dose equivalent I-131 activity level history for the North Anna 2, Cycle 2 core. The demineralizer flow rate averaged 75 gpm during power operation. The data shows that during Cycle 2, the core operated substantially below the 1.0 µCi/gm limit during steady state operation (the spike data is associated with power transients and unit shutdown). Specifically, the average dose equivalent I-131 concentration of 4.0×10^{-2} µCi/gm is equal to 4% of the Technical Specifications limit.

The ratio of the specific activities of I-131 to I-133 is used to characterize the type of fuel failure which may have occurred in the reactor core. Use of the ratio for this determination is feasible because I-133 has a short half-life (approximately 21 hours) compared to that of I-131 (approximately eight days). For pinhole defects, where the diffusion time through the defect is on the order of days, the I-133 decays out leaving the I-131 dominant in activity, thereby causing the ratio to be 0.5 or more. In the case of large leaks, uranium particles in the coolant, and "tramp" uranium*, where the diffusion mechanism is negligible, the I-131/I-133 ratio will generally be less than 0.1. Figure 5.2 shows the I-131/I-133 ratio data for the North Anna 2, Cycle 1 core. These data generally indicate there were probably a few relatively large defects in the fuel used during Cycle 2.

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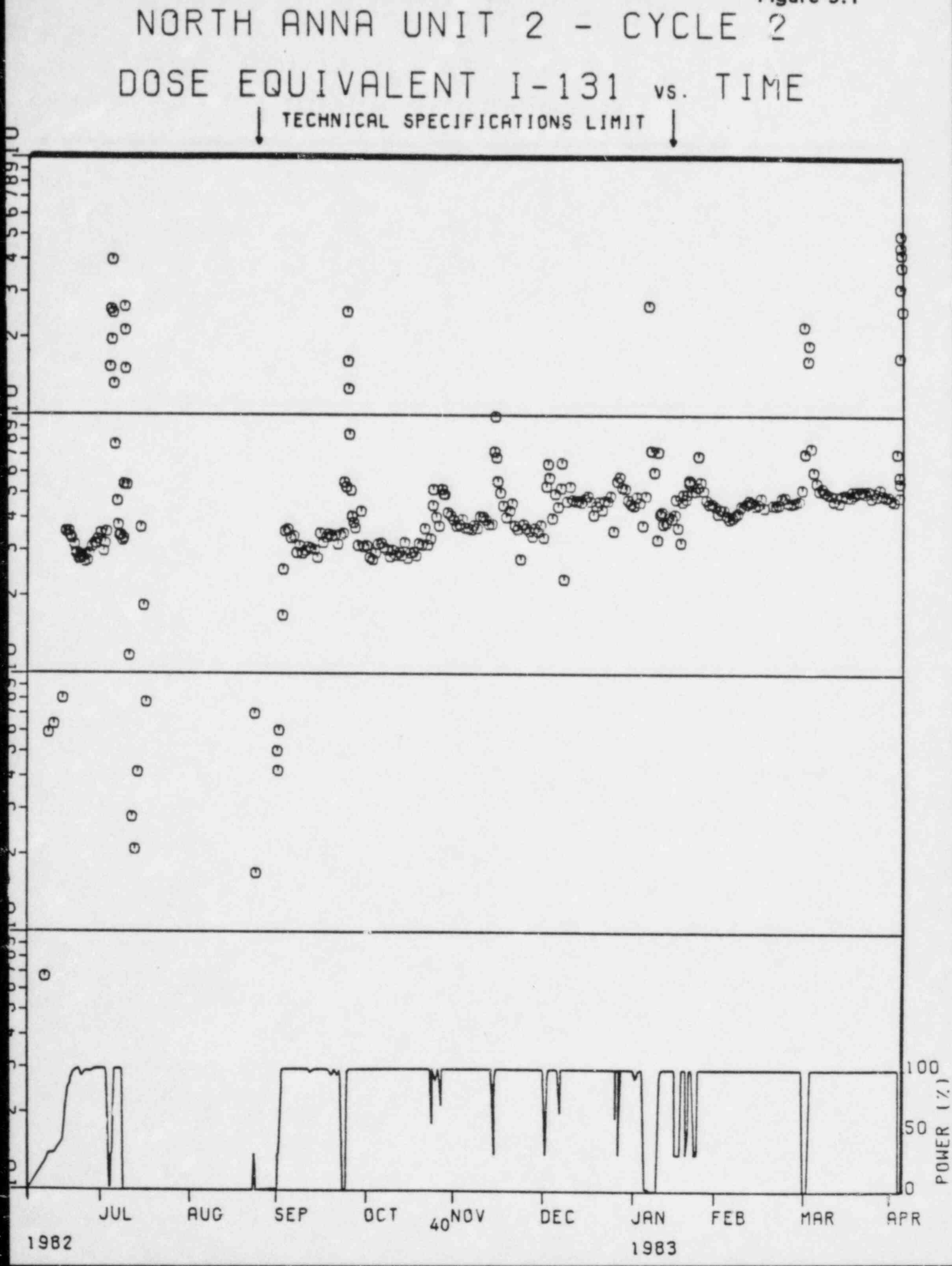
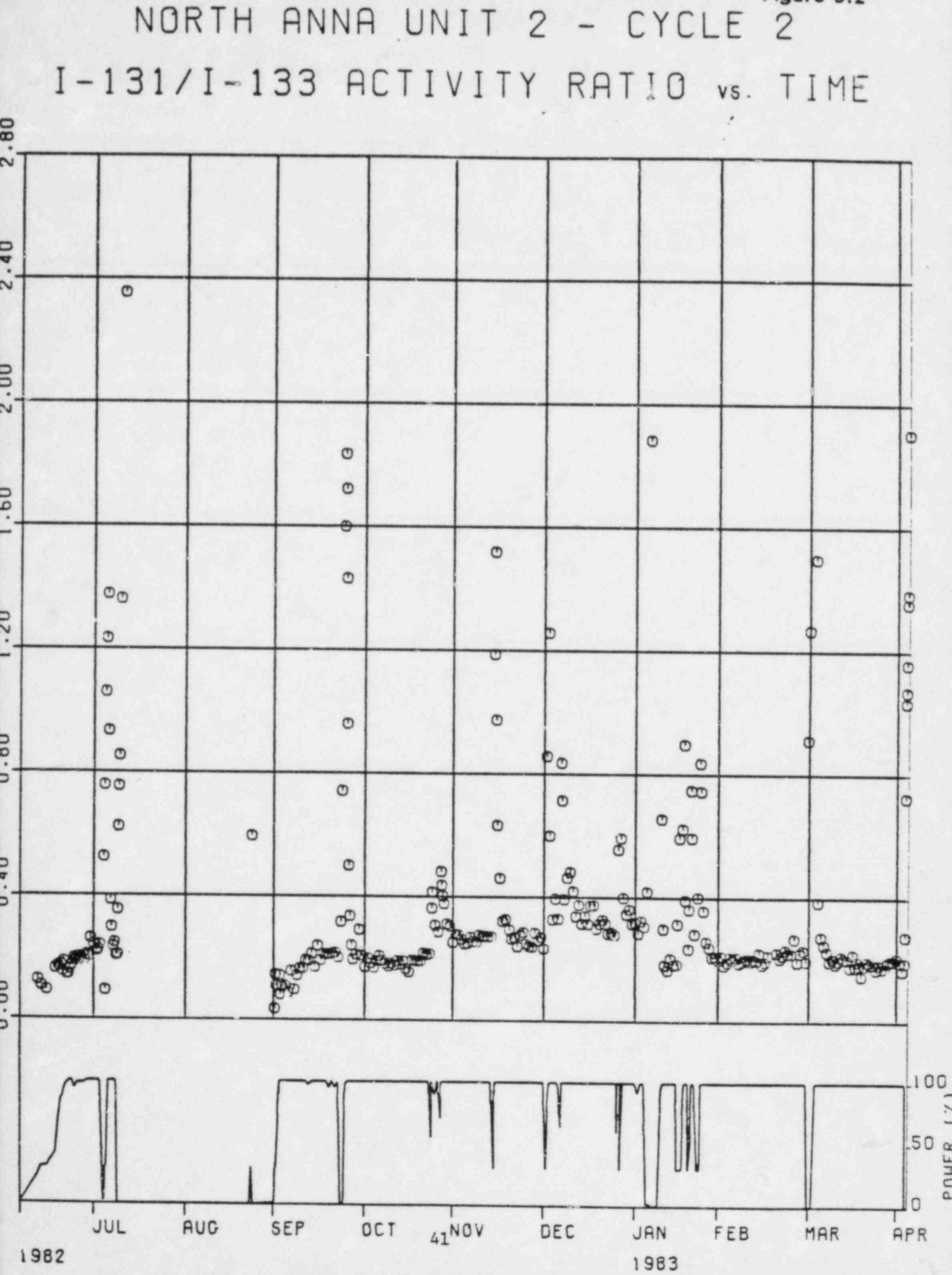
*"Tramp" uranium consists of small particles of uranium which adhere to the outside of the fuel during the manufacturing process.

Figure 5.1



NORTH ANNA UNIT 2 - CYCLE 2
DOSE EQUIVALENT I-131 vs. TIME
TECHNICAL SPECIFICATIONS LIMIT
100
50
0
POWER (%)
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
1982
1983

Figure 5.2


NORTH ANNA UNIT 2 - CYCLE 2
I-131/I-133 ACTIVITY RATIO vs. TIME
2.80
2.40
2.00
1.60
1.20
0.80
0.40
0.00
100
50
0
POWER (%)
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
1982
1983

Section 6

CONCLUSIONS

The North Anna 2, Cycle 2 core has completed operation. Throughout this cycle, all core performance indicators compared favorably with the design predictions and the core related Technical Specifications limits were met with significant margin. The minor violations of the F-XY surveillance limits existed only at the beginning of the cycle. No significant abnormalities in reactivity or burnup accumulation were detected. In addition, the mechanical integrity of the fuel has not changed significantly throughout Cycle 2 as indicated by the radioiodine analysis.

REFERENCES

1) B. D. Mann, "North Anna Unit 2, Cycle 2 Startup Physics Test Report," VEP-FRD-49, July, 1982.

2) North Anna Power Station Unit 2 Technical Specifications, Sections 3/4.1 and 3/4.2.

3) T. K. Ross, "NEWTOTE Code", NFO-CCR-6 Vepco, March, 1981.

4) R. D. Klatt, W. D. Leggett, III, and L. D. Eisenhart, "FOLLOW Code," WCAP-7482, February, 1970.

5) W. D. Leggett, III and L. D. Eisenhart, "INCORE Code," WCAP-7149, December, 1967.

6) NRC Letter, Leon B. Engle to W. L. Stewart, Amendment Nos. 45 and 28 to Facility Operating License Nos. NPF-4 and NPF-7, January 27, 1983.