3/4.1.3 MOVABLE CONTROL ASSEMBLIES

GROUP HEIGHT

LIMITING CONDITION FOR OPERATION

(Insert A)

3.1.3.1 All full length (shutdown and control) rods shall be OPERABLE and positioned within ~~± 12 steps (Analog Rod Position Indication) of~~ the group step counter demand position within one hour after rod motion. (Insert B)

APPLICABILITY: MODES 1* and 2*

ACTION:

a. With one or more full length rods inoperable due to being immovable as a result of excessive friction or mechanical interference or known to be untrippable, determine that the SHUTDOWN MARGIN requirement of Specification 3.1.1.1 is satisfied within 1 hour and be in HOT STANDBY within 6 hours.

b. With more than one full length rod inoperable or misaligned from the group step counter demand position by more than ± 12 steps ~~(Analog Rod Position Indication), be in HOT STANDBY within 6 hours.~~ (Insert C)

d ~~c~~. With one full length rod inoperable due to causes other than addressed by ACTION a, above, or misaligned from its group step counter demand position by more than ~~± 12 steps (Analog Rod Position Indication),~~ (Insert D) POWER OPERATION may continue provided that within one hour either:

1. The rod is restored to OPERABLE status within ~~the above alignment requirements~~ (Insert D), or (Insert D)

2. The remainder of the rods in the bank with the inoperable rod are aligned to within ~~± 12 steps~~ of the inoperable rod while maintaining the rod sequence and insertion limits of Specification 3.1.3.6; the THERMAL POWER level shall be restricted pursuant to Specification 3.1.3.6 during subsequent operation, or

3. The rod is declared inoperable and the SHUTDOWN MARGIN requirement of Specification 3.1.1.1 is satisfied. POWER OPERATION may then continue provided that:

9507310200 950726
PDR ADOCK 05000250
P PDR

*See Special Test Exceptions 3.10.2. and 3.10.3.

LIMITING CONDITION FOR OPERATION (Continued)

a) The THERMAL POWER level is reduced to less than or equal to 75% of RATED THERMAL POWER within one hour and within the next 4 hours the power range neutron flux high trip setpoint is reduced to less than or equal to 85% of RATED THERMAL POWER. THERMAL POWER shall be maintained less than or equal to 75% of RATED THERMAL POWER until compliance with ACTIONS 3.1.3.1.~~c~~d.3.c and 3.1.3.1.~~c~~d.3.d below are demonstrated, and

b) The SHUTDOWN MARGIN requirement of Specification 3.1.1.1 is determined at least once per 12 hours, and

c) A power distribution map is obtained from the movable incore detectors and $F_Q(Z)$ and $F^N_{\Delta H}$ are verified to be within their limits within 72 hours, and

d) A reevaluation of each accident analysis of Table 3.1-1 is performed within 5 days; this reevaluation shall confirm that the previously analyzed results of these accidents remain valid for the duration of operation under these conditions.

SURVIELLANCE REQUIREMENTS

Insert E

4.1.3.1.1 The position of each full length rod shall be determined to be within ~~± 12 steps (Analog Rod Position Indication)~~ of the group step counter demand position at least once per 12 hours (allowing for one hour thermal soak after rod motion) except during time invervals when the Rod Position Deviation Monitor is inoperable, then verify the group positions at least once per 4 hours.

4.1.3.1.2 Each full length rod not fully inserted in the core shall be determined to be OPERABLE by movement of at least 10 steps in any one direction at least once per 31 days.

TECHNICAL SPECIFICATION CHANGES - PAGES 3/4 1-17 AND 3/4 1-18

INSERT A

the Allowed Rod Misalignment between the Analog Rod Position Indication and

INSERT B

The Allowed Rod Misalignment shall be defined as:

a. for THERMAL POWER less than or equal to 90% of RATED THERMAL POWER, the Allowed Rod Misalignment is ± 18 steps, and

b. for THERMAL POWER greater than 90% of RATED THERMAL POWER, the Allowed Rod Misalignment is ± 12 steps.

INSERT C

and THERMAL POWER greater than 90% of RATED THERMAL POWER, within 1 hour either:

1. Restore all indicated rod positions to within the Allowed Rod Misalignment, or

2, Reduce THERMAL POWER to less than 90% of RATED THERMAL POWER and confirm that all indicated rod positions are within the Allowed Rod Misalignment, or

3. Be in HOT STANDBY within the following 6 hours.

c. With more than one full length rod inoperable or misaligned from the group step counter demand position by more than ± 18 steps and THERMAL POWER less than or equal to 90% of RATED THERMAL POWER, within 1 hour either:

1. Restore all indicated rod positions to within the Allowed Rod Misalignment, or

2. Be in HOT STANDBY within the following 6 hours.

INSERT D

the Allowed Rod Misalignment of Specification 3.1.3.1

INSERT E

the Allowed Rod Misalignment

POSITION INDICATION SYSTEMS - OPERATING

LIMITING CONDITION FOR OPERATION

3.1.3.2 The Analog Rod Position Indication System and the Demand Position Indication System shall be OPERABLE and capable of determining the respective actual and demanded shutdown and control rod positions as follows:

a. Analog rod position indicators, within one hour after rod motion (allowance for thermal soak):

All Shutdown Banks: ~~± 12 steps~~ Insert F of the group demand counters for withdrawal ranges of 0-30 steps and 200-~~228 steps~~ Insert G.

Control Bank A and B: ~~± 12 steps~~ Insert F of the group demand counters for withdrawal ranges of 0-30 steps and 200-~~228 steps~~ Insert G.

Control Banks C and D: ~~± 12 steps~~ Insert F of the group demand counters for withdrawal range of 0-~~228 steps~~ Insert G.

b. Group demand counters; ± 2 steps.

APPLICABILITY: MODES 1 and 2.

ACTION:

a. With a maximum of one analog rod position indicator per bank inoperable either:

1. Determine the position of the non-indicating rod(s) indirectly by the movable incore detectors at least once per 8 hours and within one hour after any motion of the non-indicating rod which exceeds 24 steps in one direction since the last determination of the rod's position, or

2. Reduce THERMAL POWER to less than 75% of RATED THERMAL POWER within 8 hours.

b. With a maximum of one demand position indicator per bank inoperable either:

1. Verify that all analog rod position indicators for the affected bank are OPERABLE and that the most withdrawn rod and the least withdrawn rod of the bank are ~~within a maximum of 12 steps of each other~~ Insert F at least once per 8 hours, or

2. Reduce THERMAL POWER to less than 75% of RATED THERMAL POWER within 8 hours.

SURVEILLANCE REQUIREMENTS

Insert F

4.1.3.2.1 Each analog rod position indicator shall be determined to be OPERABLE by verifying that the Demand Position Indication System and the Analog Rod Position Indication System agree ~~within 12 steps~~ (allowing for one hour thermal soak after rod motion) at least once per 12 hours except during time intervals when the Rod Position Deviation Monitor is inoperable, then compare the Demand Position Indication System and the Analog Rod Position Indication System at least once per 4 hours.

4.1.3.2.2 Each of the above required analog rod position indicator(s) shall be determined to be OPERABLE by performance of a CHANNEL CHECK, CHANNEL CALIBRATION and ANALOG CHANNEL OPERATIONAL TEST performed in accordance with Table 4.1-1.

TECHNICAL SPECIFICATION CHANGES - PAGES 3/4 1-20 AND 3/4 1-21

INSERT F

within the Allowed Rod Misalignment of Specification 3.1.3.1

INSERT G

All Rods Out as defined in the Core Operating Limits Report

BORATION SYSTEMS (Continued)

The charging pumps are demonstrated to be OPERABLE by testing as required by Section XI of the ASME code or by specific surveillance requirements in the specification. These requirements are adequate to determine OPERABILITY because no safety analysis assumption relating to the charging pump performance is more restrictive than these acceptance criteria for the pumps.

The boron concentration of the RWST in conjunction with manual addition of borax ensures that the solution recirculated within containment after a LOCA will be basic. The basic solution minimizes the evolution of iodine and minimizes the effect of chloride and caustic stress corrosion on mechanical systems and components. The temperature requirements for the RWST are based on the containment integrity and large break LOCA analysis assumptions.

The OPERABILITY of one Boron Injection System during REFUELING ensures that this system is available for reactivity control while in MODE 6.

The OPERABILITY requirement of 55°F and corresponding surveillance intervals associated with the boric acid tank system ensures that the solubility of the boron solution will be maintained. The temperature limit of 55°F includes a 5°F margin over the 50°F solubility limit of 3.5 wt.% boric acid. Portable instrumentation may be used to measure the temperature of the rooms containing boric acid sources and flow paths.

(*)One channel of heat tracing is sufficient to maintain the specified temperature limit. Since one channel of heat tracing is sufficient to maintain the specified temperature, operation with one channel out-of-service is permitted for a period of 30 days provided additional temperature surveillance is performed.

3/4.1.3 MOVABLE CONTROL ASSEMBLIES

The specifications of this section ensure that: (1) acceptable power distribution limits are maintained, (2) the minimum SHUTDOWN MARGIN is maintained, and (3) the potential effects of rod misalignment on associated accident analyses are limited. OPERABILITY of the control rod position indicators is required to determine control rod positions and thereby ensure compliance with the control rod alignment and insertion limits continue. OPERABLE condition for the analog rod position indicators is defined as being capable of indicating rod position to within ~~±12 steps~~ of the demand counter position. For the Shutdown Banks and Control Banks A and B, the Position Indication requirement is defined as the group demand counter indicated position between 0 and 30 steps withdrawn inclusive, and between 200 ~~and 231~~ steps withdrawn inclusive. This permits the operator to verify that the control rods in these banks are either fully withdrawn or fully inserted, the normal operating modes for these banks. Knowledge of these bank positions in these two areas satisfies all accident analysis assumptions concerning their position. For Control Banks C and D, the Position Indication requirement is defined as the group demand counter indicated position between 0 ~~and 231~~ steps withdrawn inclusive.

Insert H

Insert I

Insert I

(*)This is no longer applicable once boric acid tanks inventory and boric acid source and flow path inventories have been diluted to less than or equal to 3.5 weight percent (wt%).

MOVABLE CONTROL ASSEMBLIES (Continued)

Add → (INSERT J)

~~Comparison of the group~~ demand counters to the bank insertion limits with verification of rod position with the analog rod position indicators (after thermal soak after rod motion) is sufficient verification that the control rods are above the insertion limits.

Rod position indication is provided by two methods: a digital count of actuating pulses which shows demand position of the banks and a linear position indicator Linear Variable Differential Transformer which indicates the actual rod position. The relative accuracy of the linear position indicator Linear Variable Differential Transformer is such that, with the most adverse error, an alarm will be actuated if any two rods within a bank deviate by more than 24 steps for rods in motion and 12 steps for rods at rest. Complete rod misalignment (12 feet out of alignment with its bank) does not result in exceeding core limits in steady-state operation at RATED THERMAL POWER. If the condition cannot be readily corrected, the specified reduction in power to 75% will insure that design margins to core limits will be maintained under both steady-state and anticipated transient conditions. The 8-hour permissible limit on rod misalignment is short with respect to the probability of an independent accident.

The ACTION statements which permit limited variations from the basic requirements are accompanied by additional restrictions which ensure that the original design criteria are met. Misalignment of a rod requires measurement of peaking factors and a restriction in THERMAL POWER. These restrictions provide assurance of fuel rod integrity during continued operation. In addition, those safety analyses affected by a misaligned rod are reevaluated to confirm that the results remain valid during future operation.

The maximum rod drop time restriction is consistent with the assumed rod drop time used in the safety analyses. Measurement with T_{avg} greater than or equal to 541°F and with all reactor coolant pumps operating ensures that the measured drop times will be representative of insertion times experienced during a Reactor trip at operating conditions.

Control rod positions and OPERABILITY of the rod position indicators are required to be verified on a nominal basis of once per 12 hours with more frequent verifications required if an automatic monitoring channel is inoperable. These verification frequencies are adequate for assuring that the applicable LCOs are satisfied.

TECHNICAL SPECIFICATION CHANGES - PAGES B 3/4 1-4 AND B 3/4 1-5

INSERT H

the Allowed Rod Misalignment of Specification 3.1.3.1

INSERT I

and All Rods Out (ARO)

INSERT J

The increase in the Allowed Rod Misalignment below 90% of Rated Thermal Power is as a result of the increase in the peaking factor limits as reactor power is reduced.

PEAKING FACTOR LIMIT REPORT (Continued)

Factor Limit Report, the Peaking Factor Limit Report shall be provided to the NRC Document Control desk with copies to the Regional Administrator and the Resident Inspector within 30 days of their implementation, unless otherwise approved by the Commission.

The analytical methods used to generate the Peaking Factor limits shall be those previously reviewed and approved by the NRC. If changes to these methods are deemed necessary they will be evaluated in accordance with 10 CFR 50.59 and submitted to the NRC for review and approval prior to their use if the change is determined to involve an unreviewed safety question or if such a change would require amendment of previously submitted documentation.

CORE OPERATING LIMITS REPORT

6.9.1.7 Core operating limits shall be established and documented in the CORE OPERATING LIMITS REPORT (COLR) before each reload cycle or any remaining part of a reload cycle for the following:

1. Axial Flux Difference for Specifications 3.2.1.
2. Control Rod Insertion Limits for Specification 3.1.3.6.
3. Heat Flux Hot Channel Factor - $F_Q(Z)$ for Specification 3/4.2.2.
4. All Rods Out Position for Specification 3.1.3.2.

The ~~analytical methods used to determine the AFD limits shall~~ be those previously reviewed and approved by the NRC in:

1. WCAP-10216-P-A, "RELAXATION OF CONSTANT AXIAL OFFSET CONTROL F_Q SURVEILLANCE TECHNICAL SPECIFICATION," June 1983.
2. WCAP-8385, "POWER DISTRIBUTION CONTROL AND LOAD FOLLOWING PROCEDURES - TOPICAL REPORT," September 1974.

The analytical methods used to determine the K(Z) curve shall be those previously reviewed and approved by the NRC in:

1. WCAP-9220-P-A, Rev. 1, "Westinghouse ECCS Evaluation Model - 1981 Version," February 1982.
2. WCAP-9561-P-A, ADD. 3, Rev. 1, "BART A-1: A Computer Code for the Best Estimate Analysis of Reflood Transients - Special Report: Thimble Modeling W ECCS Evaluation Model."

The analytical methods used to determine the Rod Bank Insertion Limits and the All Rods Out position shall be those previously reviewed and approved by the NRC in:

1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.

The ability to calculate the COLR nuclear design parameters are demonstrated in:

1. Florida Power & Light Company Topical Report NF-TR-95-01, "Nuclear Physics Methodology for Reload Design of Turkey Point & St. Lucie Nuclear Plants".

ATTACHMENT 4

TURKEY POINT UNITS 3 AND 4

RELAXATION OF THE CONTROL RODS MISALIGNMENT REQUIREMENTS ANALYSIS

RELAXATION OF THE CONTROL RODS MISALIGNMENT REQUIREMENTS ANALYSIS

Background

The current Technical Specifications allow an individual Rod Cluster Control Assembly (RCCA) to be misaligned from the bank demand position if the misalignment is less than $\pm$ 12 steps. The Analog Rod Position Indication (ARPI) system is designed to an accuracy of 12 steps. Therefore, in order to guarantee a rod misalignment of less than 24 steps (12 steps misalignment + 12 steps ARPI uncertainty), the individual ARPI readings must be no larger than 12 steps. The Technical Specifications allow reactor operation with the control rods at the Rod Insertion Limit (RIL). The Technical Specifications also provide limits for peaking factors Fq and FΔH. As the power level is lowered, the limits for Fq and FΔH increase according to the following expressions:

$$Fq^{M}(Z) \leq [Fq]^{L}/P * [K(Z)] \text{ for } P > 0.5 \text{ (TS 3.2.2)}$$

$$F\Delta H \leq 1.62 [1.0 + 0.3*(1-P)] \text{ (TS 3.2.3)}$$

where P = Thermal Power/Rated Thermal Power
$[Fq]^{M}$ = measured heat flux hot channel factor
$[Fq]^{L}$ = heat flux hot channel factor limit
FΔH = nuclear enthalpy rise hot channel factor
K(Z) for a given core height, is specified in the K(Z) curve, defined in the Core Operating Limits Report (COLR)

These increases in the limit for Fq and FΔH can be used for accommodating a larger than $\pm$ 12 steps misalignment at a reduced power level. In order to justify the increase in allowable rod misalignment at a reduced power level, the following parameters were evaluated:

1. Reactivity Control
2. Control Rod Misoperation (i.e., dropped rods and static rod misalignment for Condition II events)
3. Rod Ejection
4. Power Operation with Misaligned Rod

The principal tool used in this analysis is the Westinghouse Advanced Nodal Computer (ANC) code (WCAP-10965-P-A, September 1986) exercised in a three dimensional mode. Full core and quarter core models were used in the analyses. In these models, each fuel assembly is described by four nodes in the xy plane and 24 axial nodes. The macroscopic cross-sections for ANC were generated by PHOENIX-P (WCAP-11596-P-A, "Qualification of the PHOENIX-P/ANC Nuclear Design Systems for Pressurized Water

Reactor Cores," June 1988). The calculations were performed by FPL using NRC approved methods per Amendments 174 and 168, issued by the NRC on June 9, 1995. ANC also has the capability of calculating discrete pin power and pin burnup from the nodal information. It should be noted that as far as this analysis is concerned, we are interested in changes in peaking factors rather than absolute values of the peaking factors.

The Unit 3 Cycle 14 model was used in the subsequent analysis since this cycle contains all fuel assemblies with axial blankets and is representative of expected future core designs. In order to demonstrate that the calculational tools used in the analysis are reasonable, the Unit 3 Cycle 14 ANC model was depleted and the results of the power distribution and boron letdown predictions were compared to the measured values. This is presented in the Appendix. The loading pattern and burnable poison loading is presented in Figures 1 and 2 while the control rod location is presented in Figure 3.

FIGURE 1

TURKEY POINT UNIT 3, CYCLE 14

REFERENCE CORE LOADING PATTERN

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
R							DD22 C-7	DD19 K-8	DD23 C-9						
P					DD02 F-9	EE52 B-9	FF26 FEED	EE33 J-7	FF28 FEED	EE47 B-7	DD14 F-7				
N				DD47 E-4	FF42 FEED	FF18 FEED	EE37 K-13	FF29 FEED	EE42 K-3	FF20 FEED	FF44 FEED	DD52 E-12			
M			DD45 D-5	FF45 FEED	EE02 K-11	EE16 L-8	EE28 E-3	DD44 P-6	EE23 E-13	EE12 G-12	EE20 K-5	FF50 FEED	DD51 D-11		
L		DD07 J-6	FF51 FEED	EE10 L-10	EE24 N-8		DD34 L-5	FF37 FEED	DD16 H-9		EE32 H-3	EE17 L-6	FF41 FEED	DD01 J-10	
K		EE50 J-2	FF21 FEED	EE18 D-7		DD31 P-8		DD43 K-2		DD30 H-2		EE11 H-5	FF22 FEED	EE49 J-14	
J	DD17 G-3	FF34 FEED	EE34 N-10	EE27 C-5	DD13 G-8		EE56 D-4	EE08 M-7	EE55 D-12		DD29 E-5	EE29 C-11	EE36 N-6	FF35 FEED	DD21 G-13
H	DD26 H-10	EE43 J-9	FF25 FEED	DD37 K-14	FF38 FEED	DD39 P-10	EE04 J-12	DD10 F-6	EE07 G-4	DD38 B-6	FF39 FEED	DD41 F-2	FF36 FEED	EE35 G-7	DD24 H-6
G	DD25 J-3	FF27 FEED	EE38 C-10	EE25 N-5	DD33 L-11		EE54 M-4	EE19 D-9	EE53 M-12		DD03 J-8	EE22 N-11	EE39 C-6	FF32 FEED	DD28 J-13
F		EE45 G-2	FF23 FEED	EE14 H-11		DD32 H-14		DD42 F-14		DD36 B-8		EE03 M-9	FF17 FEED	EE51 G-14	
E		DD06 G-6	FF52 FEED	EE15 E-10	EE21 H-13		DD12 H-7	FF40 FEED	DD35 E-11		EE26 C-8	EE05 E-6	FF43 FEED	DD08 G-10	
D			DD50 M-5	FF48 FEED	EE09 F-11	EE13 J-4	EE31 L-3	DD40 B-10	EE30 L-13	EE06 E-8	EE01 F-5	FF49 FEED	DD49 M-11		
C				DD48 L-4	FF46 FEED	FF24 FEED	EE40 F-13	FF33 FEED	EE41 F-3	FF19 FEED	FF47 FEED	DD46 L-12			
B					DD05 K-9	EE46 P-9	FF30 FEED	EE44 G-9	FF31 FEED	EE48 P-7	DD09 K-7				
A							DD18 N-7	DD27 F-8	DD20 N-9						

270°

180°

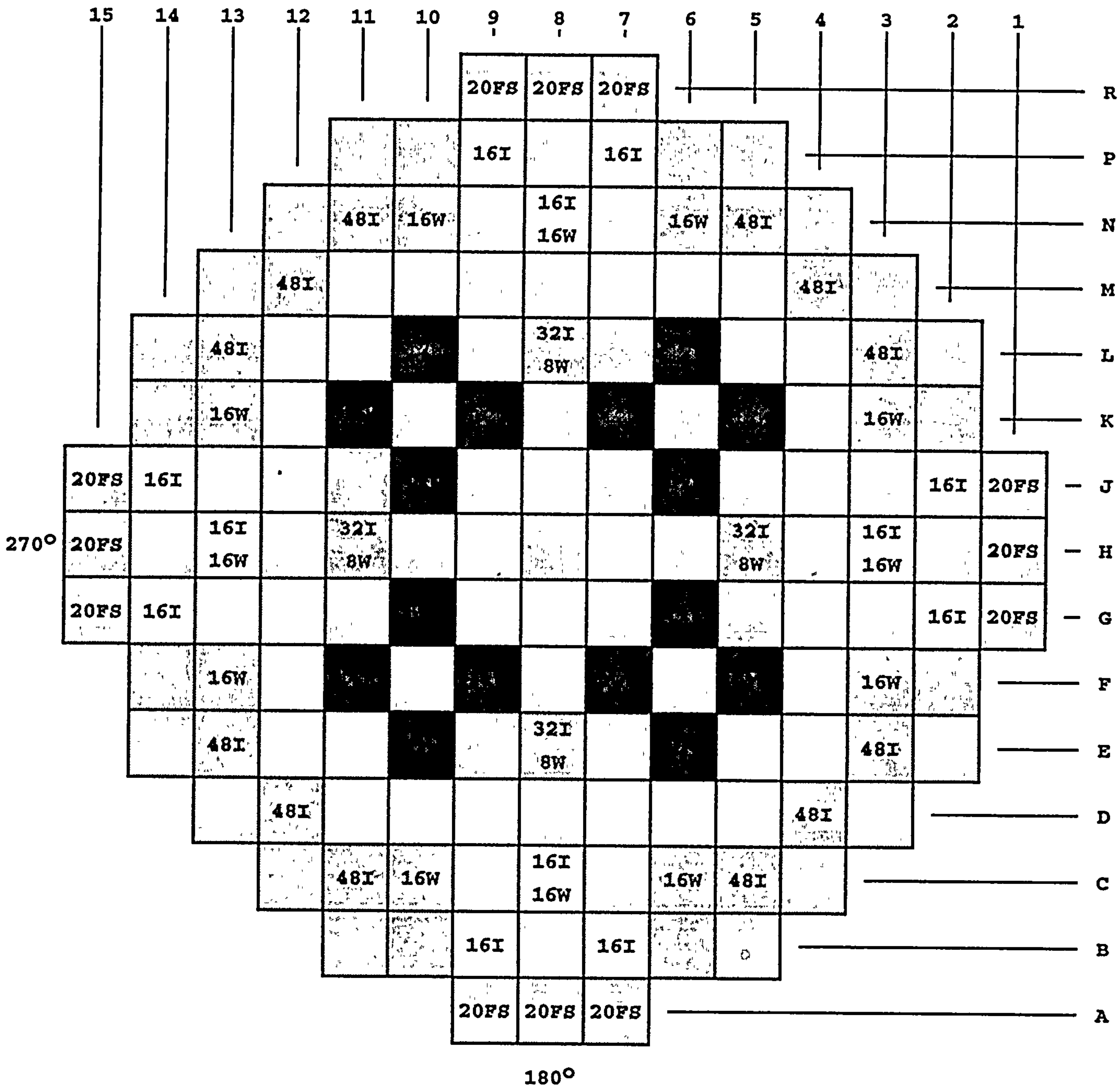
DD	REGION 14A	(3.408 w/o)
DD	REGION 14B	(3.413 w/o)
DD	REGION 14C	(3.415 w/o)
DD	REGION 14D	(3.812 w/o)
DD	REGION 14E	(3.813 w/o)
EE	REGION 15A	(3.605 w/o)
EE	REGION 15B	(3.605 w/o)
EE	REGION 15C	(3.606 w/o)
EE	REGION 15D	(4.007 w/o)
EE	REGION 15E	(4.010 w/o)
	REGION 16A	(3.600 w/o)
FF	REGION 16B	(4.000 w/o)
FF	REGION 16C	(4.000 w/o)
FF	REGION 16D	(4.000 w/o)
FF	REGION 16E	(4.000 w/o)

Y YY	WESTINGHOUSE ASSEMBLY ID
Z-ZZ	PREVIOUS CYCLE LOCATION

FIGURE 2

TURKEY POINT UNIT 3, CYCLE 14

BURNABLE ABSORBER AND SOURCE ROD LOCATIONS

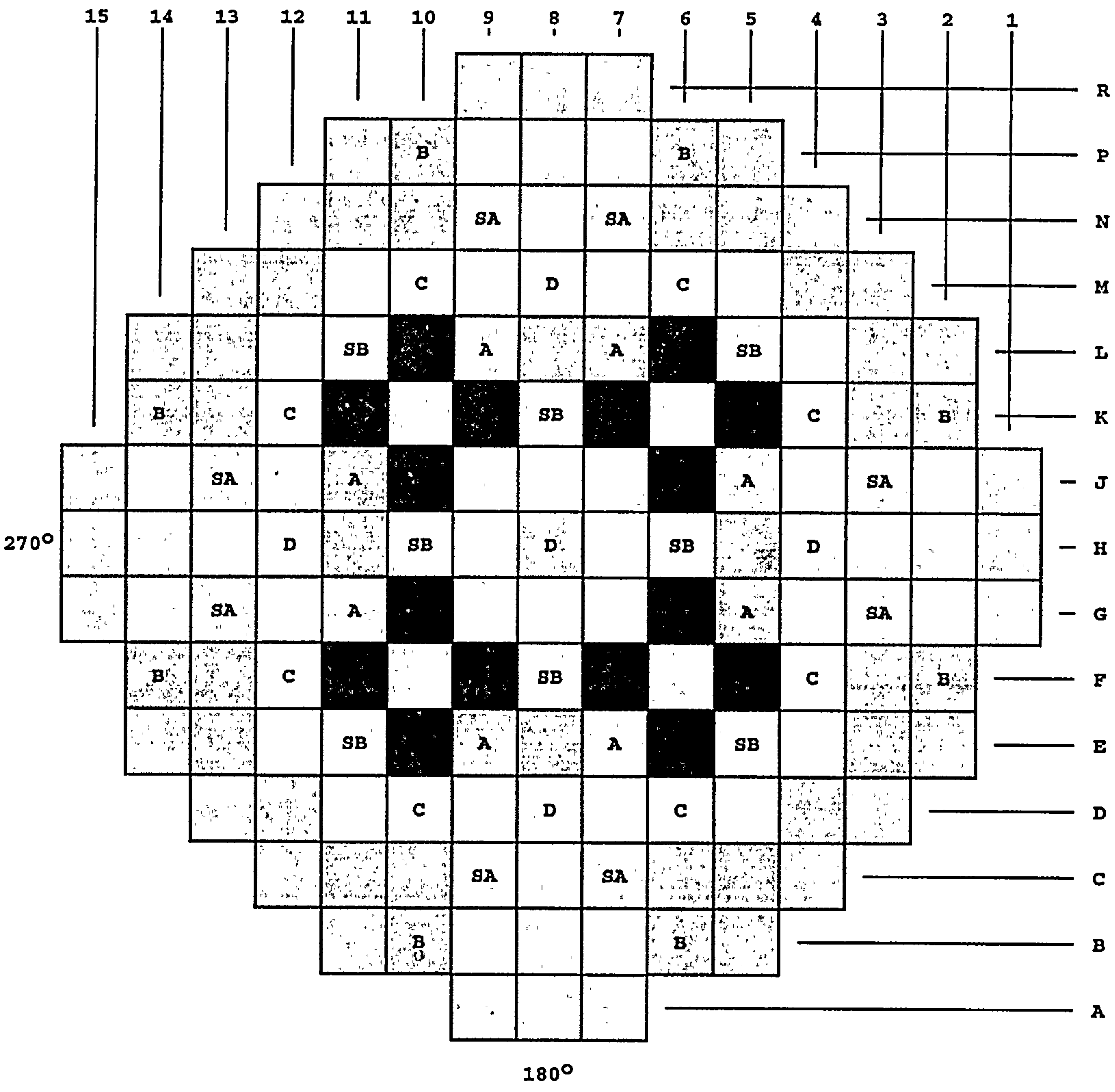


TYPE	TOTAL
##W...(NUMBER OF WABA RODLETS)...............	416
##I...(NUMBER OF IFBA RODS)..................	896
##FS..(NUMBER OF FLUX SUPPRESSION RODLETS)...	240

FIGURE 3

TURKEY POINT UNIT 3, CYCLE 14

CONTROL AND SHUTDOWN ROD LOCATIONS



BANK IDENTIFIER	NUMBER OF LOCATIONS
A	8
B	8
C	8
D	5

BANK IDENTIFIER	NUMBER OF LOCATIONS
SA	8
SB	8

1. Reactivity Control

At all times it is necessary to maintain enough control rod worth out of the core to safely shutdown the reactor with a suitable margin allowed for accidents. In order to maintain this required shutdown margin, the RIL is implemented. The amount of reactivity associated with this insertion limit is called the rod insertion allowance. RCCAs which are misaligned inward from their bank demand position will add to the rod insertion allowance. The reactivity of a misaligned bank (Control Bank D) by 30 steps past the insertion limit was calculated to be 130 pcm (Reference 6.1). The calculation was performed at 90% of RTP at End of Life (EOL) with the D-bank positioned at 151 steps, which corresponds to the RIL at 90% of RTP and 121 steps. This calculation was performed at EOL since it represents the point in the cycle with the least available excess shutdown margin. The approach is conservative since the calculation assumed the entire bank (5 RCCAs) was misaligned. The 130 pcm is substantially less than the excess shutdown margin available for past cycles in both units (see Table 1.1 and Table 1.2 for Unit 3 and Unit 4, respectively obtained from Reference 6.1). Therefore, it can be concluded from Tables 1.1 and 1.2 that reactivity control is not significantly impacted by rod misalignment.

TABLE 1.1

Unit 3 Excess Shutdown Margin

Parameter	Cycle				
	10	**11**	**12**	**13**	**14**
Net Rod Worth Less Uncertainty (pcm)	5890*	5850*	6000	5860	5930
Total Requirements (pcm)	3440	3390	3350	3180	3360
Required Shutdown Margin (pcm)	1770	1770	1770	1770	1770
Excess Shutdown Margin (pcm)	680	690	880	910	800

* Based on 10% rod worth uncertainty rather than 7% currently used.

TABLE 1.2

Unit 4 Excess Shutdown Margin

Parameter	Cycle				
	11	12	13	14	15
Net Rod Worth Less Uncertainty (pcm)	5770*	6070*	5610	6250	5710
Total Requirements (pcm)	3620	3220	3150	3210	3340
Required Shutdown Margin (pcm)	1770	1770	1770	1770	1770
Excess Shutdown Margin (pcm)	380	1080	690	1270	600

* Based on 10% rod worth uncertainty rather than 7% currently used.

2. Control Rod Misoperation

The Turkey Point design-bases RCCA misoperation events are categorized as events which could be initiated by the movement or displacement of one RCCA bank or RCCA rod from its normal or allowable RCCA bank position. These events result in reactivity and power distribution anomalies. The events are defined as follows:

a. Dropped RCCAs

   1. Single and double rod dropped

   2. An entire dropped bank

b. Statically misaligned RCCA

   1. One rod fully inserted while D-bank is fully withdrawn.

   2. D-bank at the RIL and one rod fully withdrawn.

   3. D-bank at the RIL and one rod fully inserted.

Dropped Rods

A dropped RCCA or assembly bank are detected by the following:

a. Sudden drop in the core power level as seen by the Excore Nuclear Instrumentation System

b. Asymmetric power distribution as seen by the Excore Nuclear Instrumentation System

c. Rod bottom light(s)

d. Rod deviation alarm

e. Rod position indication

Each reload is analyzed for dropped rod and dropped bank events to ensure that the Departure from Nucleate Boiling (DNB) acceptance criteria are met. The impact due to the power distribution is minimal since the additional misalignment of six steps (18 steps less the 12 steps) is allowed only below 90% of RTP where there is sufficient margin to the Fq and FΔH limit. Power distribution calculations were performed and are detailed in Section 4.

Because Turkey Point has disconnected and removed all circuity associated with automatic rod withdrawal, the possibility of an automatic rod withdrawal as a result of a dropped RCCA has been eliminated.

Statically Misaligned

A statically misaligned RCCA is detected by the following:

a. Asymmetric power distribution alarm as seen by the Excore Nuclear Instrumentation System

b. Rod deviation alarm

c. Rod position indication

In the case of a statically misaligned RCCA, an analysis is performed each reload to show that the Departure from Nucleate Boiling Ratio (DNBR) does not fall below the limiting value. The most severe misalignments with respect to DNBR are the cases where one RCCA is fully inserted with control bank D to the RIL or the ARO position, or where control bank D is inserted to the RIL with one RCCA fully withdrawn. Multiple independent alarms are available which alert the operators well before the postulated condition is approached. Therefore, the additional misalignment of six steps (18 steps less the 12 steps) below 90% of RTP is well within the current analysis and thus remains bounded.

3. Rod Ejection

The design-basis Rod Ejection event is defined by an assumed failure of a control rod mechanism pressure housing such that the reactor coolant system would eject the control rod and drive shaft to the fully withdrawn position. The consequences of this mechanical failure is a rapid positive reactivity insertion together with an adverse core power distribution, possibly leading to localized fuel rod damage.

The analysis is performed at Hot Zero Power (HZP) and Hot Full Power (HFP), Begining of Life (BOL) and EOL conditions. The physics parameters of interest are the ejected rod worth and the post-ejection Fq. The calculation is performed with the control rods at the RIL for HZP and HFP conditions.

A control rod which is misaligned from its bank at the RIL can slightly increase the available ejected rod worth. With the control rods positioned at the RIL corresponding to HZP, control bank D is fully inserted, however, control bank C is

only partially inserted. Calculations were performed at BOL and EOL HZP conditions (Reference 6.1) which indicate that the ejected rod worth of the control bank D rods (except center RCCA) from the fully inserted position was always higher than that of the control bank C rods at six steps (18 steps less than 12 steps) below the RIL. In comparison with the worth of the center bank D RCCA, the additional ejected rod worth of the bank C rods is calculated to be approximately 31 pcm. This calculation is conservative since the entire control bank C was positioned six steps below the rod insertion limit which increases the ejected rod worth of the ejected control bank C rods.

At HFP, the only control bank inserted is control bank D. Calculations were performed (Reference 6.1) which indicate that positioning the bank six steps below the RIL will insignificantly increase the ejected rod worth. This calculation is conservative since the entire control bank D is positioned six steps below the RIL which increases the ejected rod worth.

The ejected Fq is insensitive to the initial position of the rod being ejected and slightly sensitive to the position of the other rods in the core at the time of the rod ejection. If the entire bank is misaligned six steps below the RIL, the ejected Fq for any of these rods will be slightly higher (less than 2% increase at HFP). However, calculations (Reference 6.1) showed that even with this conservative assumption, the ejected Fq was below that assumed in the Safety Analysis and consequently, the average fuel pellet enthalpy and centerline temperature remained below their limits.

4. <u>Power Operation with Misaligned Rod</u>

Operation with an RCCA significantly misaligned from its bank demand position would normally be detected and promptly realigned. In the unlikely event that operation with a control rod misalignment of greater than 24 steps (12 steps per the Technical Specifications and 12 steps for the ARPI uncertainty) would occur, the impact on the power distribution would be a concern. The increase in peaking factors due to a single RCCA may be small but misalignment of one group of RCCAs may contribute to increases in peaking factors. Power distributions with control rod misalignment of 30 steps (18 steps misalignment + 12 steps for the ARPI uncertainty) were therefore evaluated in detail.

Neutronic analyses were performed to evaluate the impact of RCCA misalignment on steady state power distribution and normal operational transients such as load follow operations. Calculations were performed for both inward and outward misalignments from the demand counter position.

Current Technical Specifications require that the reactor operation be restricted to the Relaxed Axial Offset Control (RAOC) AFD band limit specified in the Core Operating Limits Report (typically +7/-10 at 100% of RTP and +25/-30 at 50% of RTP for Turkey Point). Operation within these limits ensures that the power distributions will meet the limit on heat flux hot channel factor. The Technical Specifications on quadrant power tilt ratio ensures that the radial power distribution does not deviate substantially from the measured steady state power distribution between flux maps. Therefore, limits on axial offset and quadrant power tilt ratio are vital to maintaining satisfactory power distribution and ensures that most of the RCCA misalignments are detected and corrected in a timely manner.

The change in peaking factors due to operation at lower power levels without RCCA misalignment was investigated. As seen in Table 4.1 through 4.3, peaking factors Fq and FΔH do not change substantially with power level, provided that the Axial Flux Difference (AFD) is maintained approximately constant. On the other hand, the limits change significantly according to the equations provided in the Technical Specifications. Specifically, at 90% of RTP, the Fq limit increases by 11.1% while the FΔH limit increases by 3.0%.

This increase in the limit can be used to accommodate the increase in rod misalignment of 30 steps (18 step indicated + 12 steps ARPI uncertainty). Multiple RCCA misalignment was addressed by analyzing misalignments of RCCA groups in the control banks (e.g., Groups 1 and 2 in Control Bank D). Group misalignment was considered since it is more realistic to assume that the RCCAs in one group mis-step rather than multiple RCCAs from different groups would mis-step. Also, single RCCA misalignments were performed. Tables 4.4 through 4.15 present the results of the comparison in peaking factors assuming an initial Control Bank D position at the RIL corresponding to 90% of RTP. A comparison was made between the 30 step case (18 step misalignment + 12 step ARPI uncertainty) and the allowed 24 step case (12 step misalignment + 12 step ARPI uncertainty) and their differences with the Base case (control bank D at the RIL). The results indicate that the incremental increase in Fq and FΔH due to the additional misalignment of six steps is 0.78%

and 0.53%, respectively. The maximum increases from the base case are 4.46% and 2.42% for Fq and FΔH, respectively.

Sensitivity runs were also performed for similar RCCA misalignments from 200 steps rather than from the RIL. This is considered the most realistic approach since the plant normally operates significantly above the RIL. Tables 4.16 through 4.27 present the results. The results show that the incremental increase from the additional six steps misalignment is 1.08% and 0.27% for Fq and FΔH, respectively. The maximum difference between the misalignment cases and the base case (i.e., all RCCAs at 200 steps) is 7.33% and 2.57% for Fq and FΔH, respectively.

The effect of load-follow maneuvers and misalignment on peaking factors was also investigated with a variety of axial power distributions which can be obtained by skewing the EOL xenon distribution to the bottom and top of the core. An option in the ANC code was used to get the skewed xenon distribution. The results of the analyses are presented in Tables 4.28 through 4.35. The results indicate that the incremental increase in Fq and FΔH due to the additional misalignment of six steps is 2.05% and 0.65%, respectively. The maximum increase from the base case is 6.51% and 2.58% for Fq and FΔH, respectively. The available margin from 100% of RTP at 90% of RTP is 11.1% and 3.0% for Fq and FΔH, respectively. The available margin at 90% of RTP can be used to accommodate the increase in peaking factors presented in the previous analyses. Therefore, it can be concluded that an 18 step misalignment up to 90% of RTP is acceptable.

TABLE 4.1

BOL Control Bank D Inserted to Hold Constant AFD

Description	Fq*	Fq Limit	Margin (%)	FΔH**	FΔH Limit	Margin (%)
100% of RTP	2.001	2.320	15.96	1.515	1.620	6.91
90% of RTP	2.025	2.578	27.32	1.514	1.669	10.19
80% of RTP	2.047	2.900	41.65	1.514	1.717	13.40
70% of RTP	2.070	3.314	60.11	1.514	1.766	16.61
60% of RTP	2.094	3.867	84.67	1.514	1.814	19.82
50% of RTP	2.122	4.640	118.67	1.516	1.863	22.86

* Predicted Fq is multiplied by 1.05 and 1.03 for measurement and engineering uncertainties.

** Predicted FΔH is multiplied by 1.04 for measurement uncertainty.

TABLE 4.2

MOL Control Bank D Inserted to Hold Constant AFD

Description	Fq*	Fq Limit	Margin (%)	FΔH**	FΔH Limit	Margin (%)
100% of RTP	1.894	2.320	22.51	1.518	1.620	6.69
90% of RTP	1.885	2.578	36.75	1.529	1.669	9.14
80% of RTP	1.898	2.900	52.79	1.539	1.717	11.56
70% of RTP	1.914	3.314	73.14	1.550	1.766	13.95
60% of RTP	1.935	3.867	99.85	1.562	1.814	16.15
50% of RTP	1.960	4.640	136.77	1.571	1.863	18.55

* Predicted Fq is multiplied by 1.05 and 1.03 for measurement and engineering uncertainties.

** Predicted FΔH is multiplied by 1.04 for measurement uncertainty.

TABLE 4.3

EOL Control Bank D Inserted to Hold Constant AFD

Description	Fq*	Fq Limit	Margin (%)	FΔH**	FΔH Limit	Margin (%)
100% of RTP	1.897	2.320	22.30	1.534	1.620	5.61
90% of RTP	1.862	2.578	38.42	1.534	1.669	8.77
80% of RTP	1.853	2.900	56.54	1.548	1.717	10.96
70% of RTP	1.846	3.314	79.53	1.563	1.766	12.97
60% of RTP	1.841	3.867	110.06	1.582	1.814	14.70
50% of RTP	1.913	4.640	142.53	1.612	1.863	15.57

* Predicted Fq is multiplied by 1.05 and 1.03 for measurement and engineering uncertainties.

** Predicted FΔH is multiplied by 1.04 for measurement uncertainty.

TABLE 4.4

BOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.857	1.857	0.00
Base (Bank D at RIL, 151 steps)	1.945	1.945	0.00
Misalignment of H-8	1.948	1.948	0.00
Misalignment of H-4	1.974	1.969	0.25
Misalignment of Group 1	1.961	1.959	0.10
Misalignment of Group 2	1.970	1.967	0.15
Maximum Increase From Base Case (%)	1.49	1.23	N/A
Maximum Percent Increase			0.25

Note: Control Bank D Locations
Group 1: Rods D8, M8
Group 2: Rods H4, H8 and H12

TABLE 4.5

BOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.857	1.857	0.00
Base (Bank D at RIL, 151 steps)	1.945	1.945	0.00
Misalignment of H-8	1.940	1.942	-0.10
Misalignment of H-4	1.947	1.947	0.00
Misalignment of Group 1	1.918	1.925	-0.36
Misalignment of Group 2	1.919	1.923	-0.21
Maximum Increase From Base Case (%)	0.10	0.10	N/A
Maximum Percent Increase			0.00

TABLE 4.6

MOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.701	1.701	0.00
Base (Bank D at RIL, 151 steps)	1.944	1.944	0.00
Misalignment of H-8	1.962	1.958	0.20
Misalignment of H-4	1.977	1.971	0.30
Misalignment of Group 1	1.999	1.991	0.40
Misalignment of Group 2	2.019	2.008	0.55
Maximum Increase From Base Case (%)	3.86	3.29	N/A
Maximum Percent Increase			0.55

TABLE 4.7

MOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.701	1.701	0.00
Base (Bank D at RIL, 151 steps)	1.944	1.944	0.00
Misalignment of H-8	1.915	1.921	-0.31
Misalignment of H-4	1.909	1.917	-0.42
Misalignment of Group 1	1.867	1.885	-0.95
Misalignment of Group 2	1.841	1.864	-1.23
Maximum Increase From Base Case (%)	0.00	0.00	N/A
Maximum Percent Increase			0.00

TABLE 4.8

EOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at RIL, 151 steps)	1.973	1.973	0.00
Misalignment of H-8	1.995	1.992	0.15
Misalignment of H-4	2.007	2.000	0.35
Misalignment of Group 1	2.036	2.026	0.49
Misalignment of Group 2	2.061	2.045	0.78
Maximum Increase From Base Case (%)	4.46	3.65	N/A
Maximum Percent Increase			0.78

TABLE 4.9

EOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at RIL, 151 steps)	1.973	1.973	0.00
Misalignment of H-8	1.940	1.947	-0.36
Misalignment of H-4	1.927	1.939	-0.62
Misalignment of Group 1	1.881	1.903	-1.16
Misalignment of Group 2	1.849	1.878	-1.54
Maximum Increase From Base Case (%)	0.00	0.00	N/A
Maximum Percent Increase			0.00

TABLE 4.10

BOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps $F\Delta H$	Misalignment by 12 Steps $F\Delta H$	Percent Difference
ARO	1.457	1.457	0.00
Base (Bank D at RIL, 151 steps)	1.451	1.451	0.00
Misalignment of H-8	1.454	1.453	0.07
Misalignment of H-4	1.472	1.469	0.20
Misalignment of Group 1	1.464	1.461	0.21
Misalignment of Group 2	1.467	1.464	0.20
Maximum Increase From Base Case (%)	1.45	1.24	N/A
Maximum Percent Increase			0.21

TABLE 4.11

BOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.457	1.457	0.00
Base (Bank D at RIL, 151 steps)	1.451	1.451	0.00
Misalignment of H-8	1.467	1.462	0.34
Misalignment of H-4	1.473	1.468	0.34
Misalignment of Group 1	1.452	1.452	0.00
Misalignment of Group 2	1.461	1.457	0.27
Maximum Increase From Base Case (%)	1.52	1.17	N/A
Maximum Percent Increase			0.34

TABLE 4.12

MOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.466	1.466	0.00
Base (Bank D at RIL, 151 steps)	1.490	1.490	0.00
Misalignment of H-8	1.496	1.495	0.07
Misalignment of H-4	1.509	1.506	0.20
Misalignment of Group 1	1.510	1.507	0.20
Misalignment of Group 2	1.516	1.511	0.33
Maximum Increase From Base Case (%)	1.74	1.41	N/A
Maximum Percent Increase			0.33

TABLE 4.13

MOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps $F\Delta H$	Misalignment by 12 Steps $F\Delta H$	Percent Difference
ARO	1.466	1.466	0.00
Base (Bank D at RIL, 151 steps)	1.490	1.490	0.00
Misalignment of H-8	1.485	1.486	-0.07
Misalignment of H-4	1.526	1.518	0.53
Misalignment of Group 1	1.506	1.502	0.27
Misalignment of Group 2	1.500	1.498	0.13
Maximum Increase From Base Case (%)	2.42	1.88	N/A
Maximum Percent Increase			0.53

TABLE 4.14

EOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at RIL, 151 steps)	1.495	1.495	0.00
Misalignment of H-8	1.500	1.499	0.07
Misalignment of H-4	1.511	1.509	0.13
Misalignment of Group 1	1.513	1.510	0.20
Misalignment of Group 2	1.517	1.514	0.20
Maximum Increase From Base Case (%)	1.47	1.27	N/A
Maximum Percent Increase			0.20

TABLE 4.15

EOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at RIL, 151 steps)	1.495	1.495	0.00
Misalignment of H-8	1.490	1.491	-0.07
Misalignment of H-4	1.527	1.519	0.53
Misalignment of Group 1	1.509	1.506	0.20
Misalignment of Group 2	1.504	1.501	0.20
Maximum Increase From Base Case (%)	2.14	1.61	N/A
Maximum Percent Increase			0.53

TABLE 4.16

BOL Control Bank D at 200 Steps, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.857	1.857	0.00
Base (Bank D at 200 steps)	1.875	1.875	0.00
Misalignment of H-8	1.873	1.874	-0.05
Misalignment of H-4	1.887	1.885	0.11
Misalignment of Group 1	1.893	1.889	0.21
Misalignment of Group 2	1.897	1.892	0.26
Maximum Increase From Base Case (%)	1.17	0.91	N/A
Maximum Percent Increase			0.26

Note: Control Bank D Locations
Group 1:
Group 2:

TABLE 4.17

BOL Control Bank D at 200 Steps, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.857	1.857	0.00
Base (Bank D at 200 steps)	1.875	1.875	0.00
Misalignment of H-8	1.874	1.874	0.00
Misalignment of H-4	1.873	1.873	0.00
Misalignment of Group 1	1.867	1.868	-0.05
Misalignment of Group 2	1.865	1.867	-0.11
Maximum Increase From Base Case (%)	0.00	0.00	N/A
Maximum Percent Increase			0.00

TABLE 4.18

MOL Control Bank D at 200 Steps, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.701	1.701	0.00
Base (Bank D at 200 steps)	1.759	1.759	0.00
Misalignment of H-8	1.786	1.782	0.22
Misalignment of H-4	1.798	1.791	0.39
Misalignment of Group 1	1.835	1.822	0.71
Misalignment of Group 2	1.863	1.845	0.98
Maximum Increase From Base Case (%)	5.91	4.89	N/A
Maximum Percent Increase			0.98

TABLE 4.19

MOL Control Bank D at 200 Steps, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.701	1.701	0.00
Base (Bank D at 200 steps)	1.759	1.759	0.00
Misalignment of H-8	1.745	1.746	-0.06
Misalignment of H-4	1.740	1.742	-0.11
Misalignment of Group 1	1.719	1.721	-0.12
Misalignment of Group 2	1.704	1.708	-0.23
Maximum Increase From Base Case (%)	0.00	0.00	N/A
Maximum Percent Increase			0.00

TABLE 4.20

EOL Control Bank D 200 Steps, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at 200 steps)	1.747	1.747	0.00
Misalignment of H-8	1.780	1.775	0.28
Misalignment of H-4	1.794	1.787	0.39
Misalignment of Group 1	1.841	1.826	0.82
Misalignment of Group 2	1.875	1.855	1.08
Maximum Increase From Base Case (%)	7.33	6.18	N/A
Maximum Percent Increase			1.08

TABLE 4.21

EOL Control Bank D at 200 Steps, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at 200 steps)	1.747	1.747	0.00
Misalignment of H-8	1.724	1.725	-0.06
Misalignment of H-4	1.722	1.717	0.29
Misalignment of Group 1	1.725	1.716	0.52
Misalignment of Group 2	1.741	1.731	0.58
Maximum Increase From Base Case (%)	0.00	0.00	N/A
Maximum Percent Increase			0.58

TABLE 4.22

BOL Control Bank D at 200 Steps, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.457	1.457	0.00
Base (Bank D at 200 steps)	1.454	1.454	0.00
Misalignment of H-8	1.432	1.435	-0.21
Misalignment of H-4	1.465	1.463	0.14
Misalignment of Group 1	1.463	1.461	0.14
Misalignment of Group 2	1.442	1.442	0.00
Maximum Increase From Base Case (%)	0.76	0.62	N/A
Maximum Percent Increase			0.14

TABLE 4.23

BOL Control Bank D at 200 Steps, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.457	1.457	0.00
Base (Bank D at 200 steps)	1.454	1.454	0.00
Misalignment of H-8	1.465	1.464	0.07
Misalignment of H-4	1.456	1.456	0.00
Misalignment of Group 1	1.451	1.451	0.00
Misalignment of Group 2	1.462	1.462	0.00
Maximum Increase From Base Case (%)	0.76	0.69	N/A
Maximum Percent Increase			0.07

TABLE 4.24

MOL Control Bank D at 200 Steps, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps $F\Delta H$	Misalignment by 12 Steps $F\Delta H$	Percent Difference
ARO	1.466	1.466	0.00
Base (Bank D at 200 steps)	1.473	1.473	0.00
Misalignment of H-8	1.478	1.477	0.07
Misalignment of H-4	1.492	1.489	0.20
Misalignment of Group 1	1.493	1.489	0.27
Misalignment of Group 2	1.498	1.494	0.27
Maximum Increase From Base Case (%)	1.70	1.43	N/A
Maximum Percent Increase			0.27

TABLE 4.25

MOL Control Bank D at 200 Steps, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.466	1.466	0.00
Base (Bank D at 200 steps)	1.473	1.473	0.00
Misalignment of H-8	1.470	1.469	0.07
Misalignment of H-4	1.490	1.489	0.07
Misalignment of Group 1	1.479	1.479	0.00
Misalignment of Group 2	1.476	1.476	0.00
Maximum Increase From Base Case (%)	1.15	1.09	N/A
Maximum Percent Increase			0.07

TABLE 4.26

EOL Control Bank D at 200 Steps, 90% of RTP, Inward Misalignment

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at 200 steps)	1.477	1.477	0.00
Misalignment of H-8	1.483	1.483	0.00
Misalignment of H-4	1.498	1.494	0.27
Misalignment of Group 1	1.499	1.495	0.27
Misalignment of Group 2	1.504	1.500	0.27
Maximum Increase From Base Case (%)	1.83	1.56	N/A
Maximum Percent Increase			0.27

TABLE 4.27

EOL Control Bank D at 200 Steps, 90% of RTP, Outward Misalignment

Description	Misalignment by 18 Steps $F_{\Delta H}$	Misalignment by 12 Steps $F_{\Delta H}$	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at 200 steps)	1.477	1.477	0.00
Misalignment of H-8	1.474	1.474	0.00
Misalignment of H-4	1.515	1.512	0.20
Misalignment of Group 1	1.503	1.500	0.20
Misalignment of Group 2	1.499	1.496	0.20
Maximum Increase From Base Case (%)	2.57	2.37	N/A
Maximum Percent Increase			0.20

TABLE 4.28

EOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Positive AFD (Approximately +12%)

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at RIL, 151 steps)	1.967	1.967	0.00
Misalignment of H-8	1.976	1.975	0.05
Misalignment of H-4	1.981	1.979	0.10
Misalignment of Group 1	1.985	1.983	0.10
Misalignment of Group 2	1.992	1.985	0.35
Maximum Increase From Base Case (%)	1.27	0.92	N/A
Maximum Percent Increase			0.35

TABLE 4.29

EOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Positive AFD (Approximately +12%)

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at RIL, 151 steps)	1.967	1.967	0.00
Misalignment of H-8	1.980	1.976	0.20
Misalignment of H-4	2.093	2.053	1.95
Misalignment of Group 1	2.085	2.047	1.86
Misalignment of Group 2	2.095	2.053	2.05
Maximum Increase From Base Case (%)	6.51	4.37	N/A
Maximum Percent Increase			2.05

TABLE 4.30

EOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Negative AFD (Approximately -13%)

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at RIL, 151 steps)	2.074	2.074	0.00
Misalignment of H-8	2.099	2.094	0.24
Misalignment of H-4	2.113	2.106	0.33
Misalignment of Group 1	2.143	2.133	0.47
Misalignment of Group 2	2.167	2.152	0.70
Maximum Increase From Base Case (%)	4.48	3.76	N/A
Maximum Percent Increase			0.70

TABLE 4.31

EOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Negative AFD (Approximately -13%)

Description	Misalignment by 18 Steps Fq	Misalignment by 12 Steps Fq	Percent Difference
ARO	1.702	1.702	0.00
Base (Bank D at RIL, 151 steps)	2.074	2.074	0.00
Misalignment of H-8	2.043	2.051	-0.39
Misalignment of H-4	2.033	2.043	-0.49
Misalignment of Group 1	1.987	2.008	-1.05
Misalignment of Group 2	1.955	1.984	-1.46
Maximum Increase From Base Case (%)	0.00	0.00	N/A
Maximum Percent Increase			0.00

TABLE 4.32

EOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Positive AFD (Approximately +12%)

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at RIL, 151 steps)	1.509	1.509	0.00
Misalignment of H-8	1.515	1.514	0.07
Misalignment of H-4	1.526	1.524	0.13
Misalignment of Group 1	1.529	1.527	0.13
Misalignment of Group 2	1.536	1.531	0.33
Maximum Increase From Base Case (%)	1.79	1.46	N/A
Maximum Percent Increase			0.33

TABLE 4.33

EOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Positive AFD (Approximately +12%)

Description	Misalignment by 18 Steps $F\Delta H$	Misalignment by 12 Steps $F\Delta H$	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at RIL, 151 steps)	1.509	1.509	0.00
Misalignment of H-8	1.503	1.504	-0.07
Misalignment of H-4	1.548	1.538	0.65
Misalignment of Group 1	1.526	1.521	0.33
Misalignment of Group 2	1.519	1.516	0.20
Maximum Increase From Base Case (%)	2.58	1.92	N/A
Maximum Percent Increase			0.65

TABLE 4.34

EOL Control Bank D at RIL, 90% of RTP, Inward Misalignment

Negative AFD (Approximately -13%)

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at RIL, 151 steps)	1.496	1.496	0.00
Misalignment of H-8	1.501	1.500	0.07
Misalignment of H-4	1.512	1.509	0.20
Misalignment of Group 1	1.514	1.511	0.20
Misalignment of Group 2	1.518	1.515	0.20
Maximum Increase From Base Case (%)	1.47	1.27	N/A
Maximum Percent Increase			0.20

TABLE 4.35

EOL Control Bank D at RIL, 90% of RTP, Outward Misalignment

Negative AFD (Approximately -13%)

Description	Misalignment by 18 Steps FΔH	Misalignment by 12 Steps FΔH	Percent Difference
ARO	1.481	1.481	0.00
Base (Bank D at RIL, 151 steps)	1.496	1.496	0.00
Misalignment of H-8	1.492	1.493	-0.07
Misalignment of H-4	1.527	1.519	0.53
Misalignment of Group 1	1.510	1.506	0.27
Misalignment of Group 2	1.504	1.502	0.13
Maximum Increase From Base Case (%)	2.07	1.54	N/A
Maximum Percent Increase			0.53

5. Conclusions

RCCA misalignments up to 30 steps (18 steps indicated + 12 steps ARPI uncertainty) were evaluated for impact on peaking factors and reactivity worth. A review of the results of the transient analyses showed that adequate conservatism exists in the analyses to offset the penalties associated with an increased rod misalignment.

Power distributions were evaluated under steady state and load follow conditions with a rod misalignment of 30 steps (18 step indicated + 12 steps ARPI uncertainty) showing that the increase in peaking factors could be accommodated at or below 90% of RTP.

Typical plant operation is with control rods essentially fully withdrawn. Continuous plant monitoring of power tilts and AFD coupled with the fact that actual control rod misalignments are rare, make the results of the analyses presented here conservative. An actual control rod misalignment would be promptly realigned upon verification of its position.

6. References

6.1 JPN Calculation PTN-BFJF-95-001, "Physics Parameters to Support Rod Misalignment T/S Change from 12 to 18 Steps," Rev. 0, Approved 01/20/95

6.2 Liu, Y. S. et al., "ANC: A Westinghouse Advanced Nodal Computer Code," WCAP-10965-P-A, September 1986

6.3 Nguyen, T. Q., et al, "Qualification of the PHOENIX-P/ANC Nuclear Design Systems for Pressurized Water Reactor Cores," WCAP-11596-P-A, June 1988

APPENDIX

APPLICABILITY OF ANC TO TURKEY POINT UNIT 3 CYCLE 14

APPLICABILITY OF ANC TO TURKEY POINT UNIT 3 CYCLE 14

The results of the Unit 3 Cycle 14 core design using the Westinghouse code system PHOENIX-P/ANC and methodology are compared to measured data. The results from the Zero Power Physics Testing are given in Table 1. Hot Full Power (HFP) critical boron concentration obtained from ANC was compared to measured critical boron and is presented in Figure 1. The comparison of measured and predicted peaking factors is presented in Figures 2 and 3. The Beginning of Life (BOL) and Middle of Life (MOL) radial assembly power distributions are presented in Figures 4 and 5. Review of this data indicate that the ANC model is adequate for power distribution analyses. Additional comparisons between ANC and measured data is available in Topical Report NF-TR-95-01, "Nuclear Physics Methodology for Reload Design of Turkey Point & St. Lucie Nuclear Plants," January 1995.

HZP MODERATOR TEMPERATURE COEFFICIENT

Measured (pcm/F)	Predicted (pcm/F)	Difference (pcm/F)
+0.793	+0.771	+0.022

HZP ROD WORTH

Bank	Measured Worth (pcm)	Predicted Worth (pcm)	Percent Difference (P/M-1)*100
CBD	652	674	3.37
CBC	1192	1295	8.64
CBB	390	441	13.08
CBA	891	916	2.81
SBB	1130	1192	5.49
SBA	934	1002	7.28
Total	5189	5520	6.38

HZP BORON ENDPOINT MEASUREMENT

Condition	Measured (ppm)	Predicted (ppm)	Difference (ppm)
ARO	1665	1653	-12
CBC Inserted	1521	1493	-28

FIGURE 1

TURKEY POINT UNIT 3 CYCLE 14

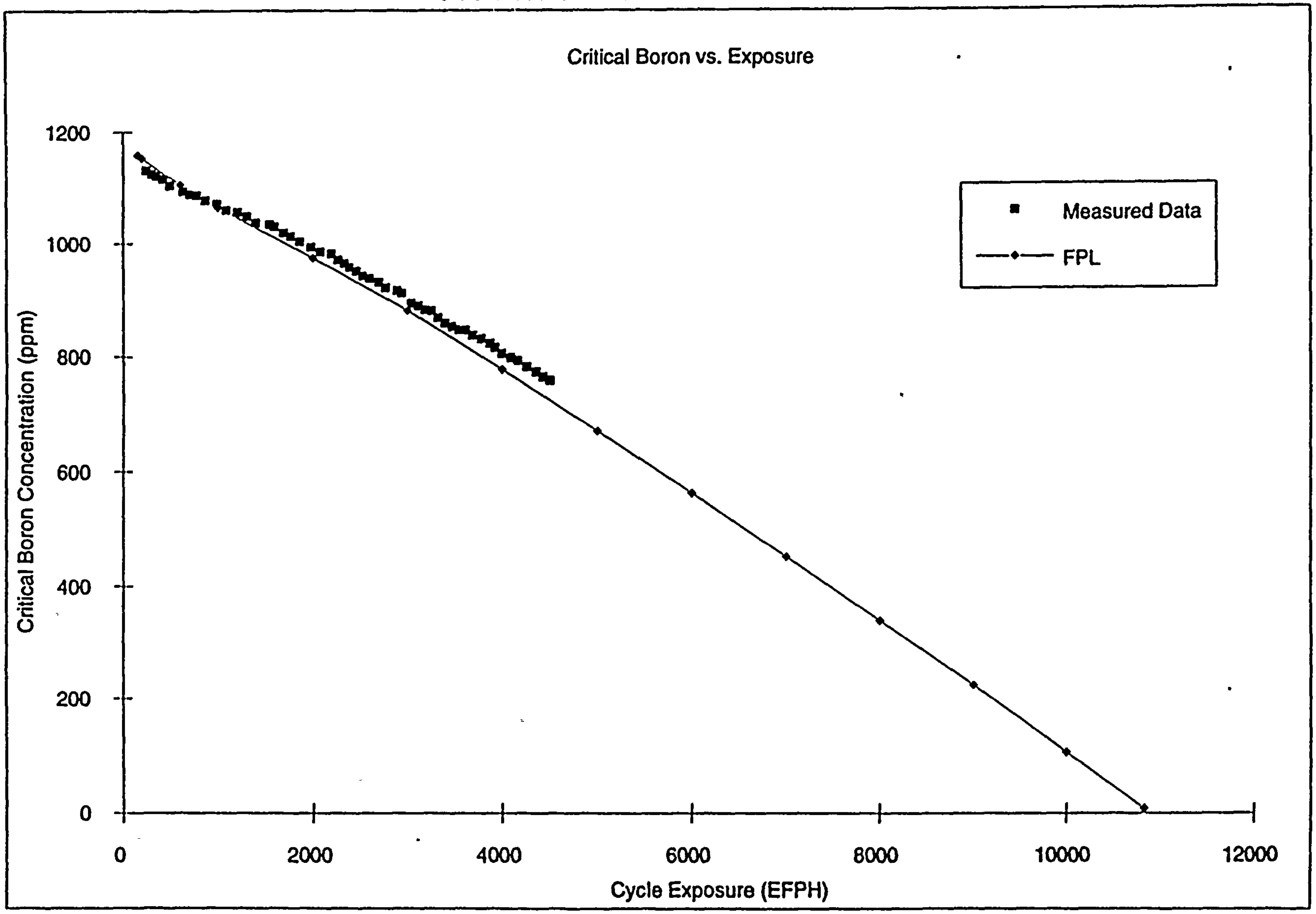


FIGURE 5

TURKEY POINT UNIT 3 CYCLE 14

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
R							0.248 0.250 -0.80%	0.275 0.278 -1.08%	0.247 0.250 -1.20%						
P					0.368 0.366 0.55%	0.802 0.786 2.04%	1.117 1.106 0.99%	0.905 0.907 -0.22%	1.105 1.106 -0.09%	0.775 0.787 -1.52%	0.360 0.366 -1.64%				
N				0.476 0.479 -0.63%	1.151 1.142 0.79%	1.345 1.318 2.05%	1.163 1.146 1.48%	1.366 1.352 1.04%	1.129 1.147 -1.57%	1.297 1.318 -1.59%	1.124 1.143 -1.66%	0.475 0.479 -0.84%			
M			0.471 0.479 -1.67%	1.146 1.147 -0.09%	1.125 1.118 0.63%	1.187 1.168 1.63%	1.175 1.154 1.82%	1.080 1.074 0.56%	1.161 1.151 0.87%	1.157 1.167 -0.86%	1.110 1.118 -0.72%	1.129 1.147 -1.57%	0.479 0.479 0.00%		
L		0.356 0.366 -2.73%	1.112 1.143 -2.71%	1.123 1.118 0.45%	1.177 1.171 0.51%	1.360 1.341 1.42%	0.956 0.936 2.14%	1.396 1.364 2.35%	0.950 0.923 2.93%	1.378 1.337 3.07%	1.132 1.171 -3.33%	1.080 1.118 -3.40%	1.144 1.142 0.18%	0.366 0.366 0.00%	
K		0.776 0.787 -1.40%	1.304 1.318 -1.06%	1.172 1.167 0.43%	1.340 1.337 0.22%	1.013 1.006 0.70%	1.361 1.346 1.11%	1.114 1.105 0.81%	1.362 1.344 1.34%	1.003 1.006 -0.30%	1.339 1.341 -0.15%	1.138 1.168 -2.57%	1.265 1.318 -4.02%	0.754 0.786 -4.07%	
J	0.248 0.250 -0.80%	1.119 1.106 1.18%	1.163 1.147 1.39%	1.156 1.151 0.43%	0.934 0.923 1.19%	1.342 1.344 -0.15%	1.245 1.247 -0.16%	1.091 1.096 -0.46%	1.242 1.247 -0.40%	1.353 1.346 0.52%	0.932 0.936 -0.43%	1.145 1.154 -0.78%	1.100 1.146 -4.01%	1.094 1.106 -1.08%	0.240 0.250 -4.00%
H	0.276 0.278 -0.72%	0.917 0.907 1.10%	1.384 1.352 2.37%	1.096 1.074 2.05%	1.413 1.364 3.59%	1.123 1.105 1.63%	1.105 1.096 0.82%	0.843 0.833 1.20%	1.111 1.096 1.37%	1.127 1.105 1.99%	1.377 1.364 0.95%	1.095 1.074 1.96%	1.379 1.352 2.00%	0.898 0.907 -0.99%	0.283 0.278 1.80%
G	0.248 0.250 -0.80%	1.129 1.106 2.08%	1.171 1.146 2.18%	1.186 1.154 2.77%	0.967 0.936 3.31%	1.389 1.346 3.19%	1.269 1.247 1.76%	1.117 1.096 1.92%	1.278 1.247 2.49%	1.371 1.344 2.01%	0.919 0.923 -0.43%	1.138 1.151 -1.13%	1.134 1.147 -1.13%	1.110 1.106 0.36%	0.246 0.250 -1.60%
F		0.802 0.786 2.04%	1.345 1.318 2.05%	1.199 1.168 2.65%	1.385 1.341 3.28%	1.035 1.006 2.88%	1.400 1.344 4.17%	1.096 1.105 -0.81%	1.360 1.346 1.04%	1.017 1.006 1.09%	1.316 1.337 -1.57%	1.119 1.167 -4.11%	1.282 1.318 -2.73%	0.777 0.787 -1.27%	
E		0.373 0.366 1.91%	1.167 1.142 2.19%	1.147 1.118 2.59%	1.209 1.171 3.25%	1.320 1.337 -1.27%	0.900 0.923 -2.49%	1.382 1.364 1.32%	0.939 0.936 0.32%	1.342 1.341 0.07%	1.150 1.171 -1.79%	1.095 1.118 -2.06%	1.112 1.143 -2.71%	0.361 0.366 -1.37%	
D			0.484 0.479 1.04%	1.160 1.147 1.13%	1.062 1.118 -5.01%	1.042 1.167 -10.71%	1.028 1.151 -10.69%	1.080 1.074 0.56%	1.161 1.154 0.61%	1.163 1.168 -0.43%	1.116 1.118 -0.18%	1.137 1.147 -0.87%	0.478 0.479 -0.21%		
C				0.485 0.479 1.25%	1.107 1.143 -3.15%	1.247 1.318 -5.39%	1.089 1.147 -5.06%	1.296 1.352 -4.14%	1.138 1.146 -0.70%	1.334 1.318 1.21%	1.160 1.142 1.58%	0.486 0.479 1.46%			
B					0.368 0.366 0.55%	0.786 0.787 -0.13%	1.093 1.106 -1.18%	0.869 0.907 -4.19%	1.119 1.106 1.18%	0.803 0.786 2.16%	0.377 0.366 3.01%				
A							0.249 0.250 -0.40%	0.274 0.278 -1.44%	0.246 0.250 -1.60%						

INCORE
ANC
% Diff.

Average Percent Difference = -0.001
Standard Deviation = 0.023

BURNUP= 6147 MWD/MTU
POWER LEVEL = 99.8 %
D Bank at 228 Steps

FIGURE 3
TURKEY POINT UNIT 3 CYCLE 14

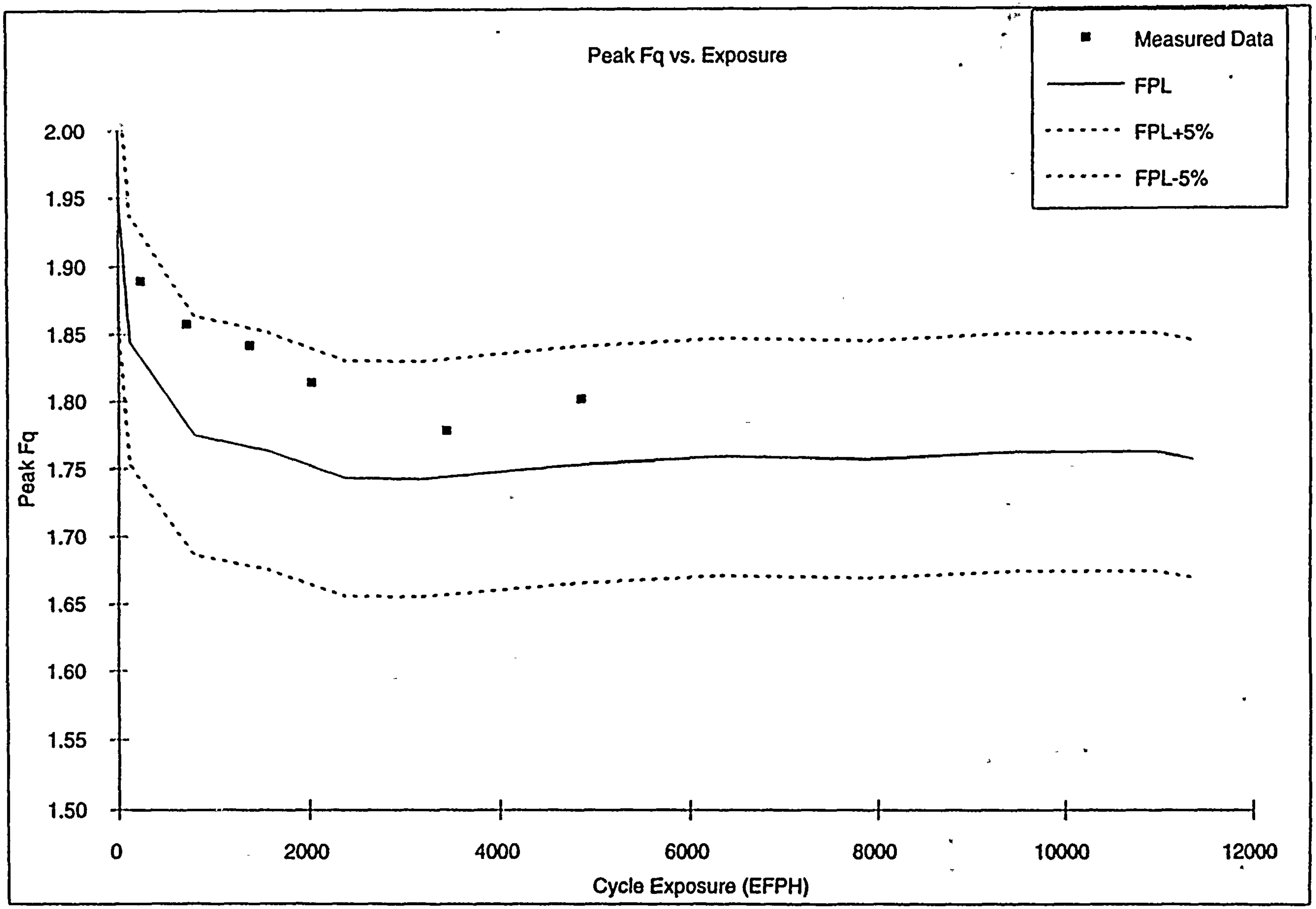


FIGURE 4

TURKEY POINT UNIT 3 CYCLE 14

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
R							0.230 0.231 -0.43%	0.252 0.253 -0.40%	0.230 0.231 -0.43%						
P					0.332 0.330 0.61%	0.783 0.764 2.49%	1.122 1.101 1.91%	0.904 0.901 0.33%	1.106 1.102 0.36%	0.761 0.765 -0.52%	0.332 0.331 0.30%				
N				0.441 0.446 -1.12%	1.080 1.071 0.84%	1.286 1.253 2.63%	1.203 1.175 2.38%	1.308 1.277 2.43%	1.155 1.175 -1.70%	1.246 1.253 -0.56%	1.078 1.071 0.65%	0.446 0.446 0.00%			
M			0.435 0.446 -2.47%	1.097 1.099 -0.18%	1.165 1.157 0.69%	1.234 1.220 1.15%	1.232 1.203 2.41%	1.119 1.104 1.36%	1.220 1.199 1.75%	1.216 1.218 -0.16%	1.161 1.157 0.35%	1.093 1.099 -0.55%	0.442 0.446 -0.90%		
L		0.317 0.331 -4.23%	1.027 1.071 -4.11%	1.164 1.157 0.61%	1.240 1.233 0.57%	1.327 1.320 0.53%	0.951 0.949 0.21%	1.386 1.323 4.76%	0.967 0.936 3.31%	1.342 1.314 2.13%	1.213 1.233 -1.62%	1.139 1.157 -1.56%	1.064 1.071 -0.65%	0.327 0.330 -0.91%	
K		0.750 0.765 -1.96%	1.225 1.253 -2.23%	1.219 1.218 0.08%	1.325 1.314 0.84%	1.031 1.021 0.98%	1.366 1.334 2.40%	1.189 1.162 2.32%	1.370 1.332 2.85%	1.021 1.021 0.00%	1.313 1.320 -0.53%	1.200 1.220 -1.64%	1.237 1.253 -1.28%	0.754 0.764 -1.31%	
J	0.230 0.231 -0.43%	1.118 1.102 1.45%	1.188 1.175 1.11%	1.194 1.199 -0.42%	0.948 0.936 1.28%	1.362 1.332 2.25%	1.387 1.357 2.21%	1.230 1.208 1.82%	1.382 1.357 1.84%	1.331 1.334 -0.22%	0.929 0.949 -2.11%	1.195 1.203 -0.67%	1.159 1.175 -1.36%	1.096 1.101 -0.45%	0.222 0.231 -3.90%
H	0.256 0.253 1.19%	0.917 0.901 1.78%	1.311 1.277 2.66%	1.119 1.104 1.36%	1.353 1.323 2.27%	1.181 1.162 1.64%	1.224 1.208 1.32%	0.925 0.915 1.09%	1.217 1.208 0.75%	1.155 1.162 -0.60%	1.305 1.323 -1.36%	1.086 1.104 -1.63%	1.310 1.277 2.58%	0.896 0.901 -0.55%	0.244 0.253 -3.56%
G	0.237 0.231 2.60%	1.129 1.101 2.54%	1.204 1.175 2.47%	1.228 1.203 2.08%	0.964 0.949 1.58%	1.354 1.334 1.50%	1.364 1.357 0.52%	1.216 1.208 0.66%	1.372 1.357 1.11%	1.335 1.332 0.23%	0.929 0.936 -0.75%	1.199 1.199 0.00%	1.173 1.175 -0.17%	1.098 1.102 -0.36%	0.225 0.231 -2.60%
F		0.783 0.764 2.49%	1.286 1.253 2.63%	1.241 1.220 1.72%	1.333 1.320 0.98%	1.033 1.021 1.18%	1.364 1.332 2.40%	1.147 1.162 -1.29%	1.334 1.334 0.00%	1.021 1.021 0.00%	1.307 1.314 -0.53%	1.206 1.218 -0.99%	1.242 1.253 -0.88%	0.757 0.765 -1.05%	
E		0.338 0.330 2.42%	1.099 1.071 2.61%	1.177 1.157 1.73%	1.244 1.233 0.89%	1.316 1.314 0.15%	0.931 0.936 -0.53%	1.324 1.323 0.08%	0.942 0.949 -0.74%	1.309 1.320 -0.83%	1.221 1.233 -0.97%	1.141 1.157 -1.38%	1.058 1.071 -1.21%	0.326 0.331 -1.51%	
D			0.424 0.446 -4.93%	1.046 1.099 -4.82%	1.113 1.157 -3.80%	1.183 1.218 -2.87%	1.166 1.199 -2.75%	1.093 1.104 -1.00%	1.191 1.203 -1.00%	1.204 1.220 -1.31%	1.136 1.157 -1.82%	1.082 1.099 -1.55%	0.438 0.446 -1.79%		
C				0.424 0.446 -4.93%	1.034 1.071 -3.45%	1.219 1.253 -2.71%	1.141 1.175 -2.89%	1.237 1.277 -3.13%	1.159 1.175 -1.36%	1.228 1.253 -2.00%	1.032 1.071 -3.64%	0.432 0.446 -3.14%			
B					0.318 0.331 -3.93%	0.744 0.765 -2.75%	1.072 1.102 -2.72%	0.872 0.901 -3.22%	1.104 1.101 0.27%	0.744 0.764 -2.62%	0.312 0.330 -5.45%				
A							0.225 0.231 -2.60%	0.248 0.253 -1.98%	0.228 0.231 -1.30%						

INCORE
ANC
% Diff.

Average Percent Difference = -0.002
Standard Deviation = 0.020

BURNUP= 300 MWD/MTU
POWER LEVEL = 99.9 %
D Bank at 228 Steps