Thimble Reduction Study for Turkey Point Units 3 and 4 Addendum No. 1

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Introduction

The purpose of this memo is to respond to the concerns voiced by Florida Power and Light (Reference 1) regarding the INCORE thimble deletion study. After reviewing the original INCORE instrumentation thimble deletion study memo (Reference 2) there were two issues for which FP&L requested more information. These issues are a) the impact on deletion of thimbles due to failure of the rotary 10-path selector devices and b) the methodology used to calculate the peaking factor uncertainties when less than 75% of the thimbles are operable. This memorandum addresses these issues.

The original study (Reference 2) assumed that deletion of INCORE instrumentation thimbles was random in nature. The next section describes the deletion of thimbles via 10-path device failure. In addition, the original study did not provide the details of the methods used to calculate the peaking factor uncertainties for flux maps with thimbles less than the 75% required by the Standard Technical Specifications. The second and third sections describe this methodology in detail.

Random Thimble Deletion Assumption

The 10-path rotary transfer device in the INCORE detector drive system is the final transfer point that determines which thimble a detector will access. When a 10-path device fails, it precludes usage of the 10 thimbles for which it controls access. The Turkey Point units have five drive systems that each have a 10-path rotary transfer device. Figure 3 shows the correspondence between 10-path selector positions for a given detector and the thimble IDs.

Since this study only considers removal of thimbles down to 50% of the total, up to 2 10-path devices can fail -- eliminating access to 20 of the thimbles. If three 10-path devices fail then 30 thimbles are deleted and less than 50% of the original 50 thimbles remain.

In Reference 2 the core was divided into two sets of quadrants. Thimbles were deleted at random and the minimum number of thimbles left in any one quadrant was determined. Quadrants are defined as they were in Reference 2 (see Figures 1 and 2). For this study, 10-path devices will eliminate the first portion of thimbles and thimbles will then be removed at random until 60% or 50% remain. Therefore, four separate cases must be examined:

A) one 10-path failure with random deletion to 60% remaining
B) one 10-path failure with random deletion to 50% remaining
C) two 10-path failures (60% remaining)
D) two 10-path failures with random deletion to 50% remaining

For the cases with two 10-path failures, all possible combinations of 10-path failures (A&B, A&C, A&D, A&E, B&C, etc) were examined to determine which combination left the fewest thimbles remaining in any one quadrant. The following table shows the results of removing the various combinations of 10-path devices.

	With Failure of Drives									
	A&B	A&C	A&D	A&E	B&C	B&D	B&E	C&D	C&E	D&E
Min Thimbles per quad	5	6	7	5	5	6	6	7	5	6

Although several combinations left as few as 5 thimbles in any one quadrant, the B&C combination was used arbitrarily. That is, for cases with two 10-path failures, thimbles accessed by devices B & C were deleted. A similar methodology was used to determine the worst single detector drive to eliminate. Drive B was selected, leaving a minimum of 8 thimbles in any one quadrant.

	With Failure of Drive				
	A	B	C	D	E
Min Thimbles per quad	9	8	9	10	8

One thousand simulations were run for each deletion case (except case "C") using a simple computer simulation program. These simulations were run to determine the minimum number of thimbles that remain in

any one quadrant after the specified number of thimbles are deleted. The following table summarizes the results for the four cases described above.

[ ]a,c

From the above table it can be seen that the results are very similar to the random deletion examined in Reference 2. Here, with deletion to 60% of thimbles, [ ]+ or more thimbles remaining per quadrant. With deletion to 50% of thimbles, [ ]+ there will be at least 3 or more thimbles remaining per quadrant. +a,c +a,c

The results from the random thimble deletion were [60% of thimbles, greater than 98% of the time there will be at least 4]+ with deletion to 50% of thimbles, [ ]+ there will be at least 3 or more thimbles remaining per quadrant. +a,c +a,c

[ ]+ When deleting to 50% of the thimbles, the minimum remaining per quadrant is three. +a,c

Comparison of Reaction Rate Errors in Turkey Point to Other Three-Loop Cores

Data has been collected for a thimble deletion study of Westinghouse three-loop reactors. The conclusions of this study should be applicable to both the current cycles at Turkey Point and all future cycles if the Tech Spec changes are to be permanent ones. Flux maps were collected from three different three-loop reactors with different reload fuel management strategies. These other three-loop reactors all have INCORE thimble patterns identical to the Turkey Point units. The three reactors will be designated Plants "A", "B", and "C". The similarity of these plants to the Turkey Point units provides justification for comparison.

Cycle 8 of plant "A" used an 18 month, low leakage loading pattern, with high discharge burnup, standard fuel, and WABAs. Cycle 4 of plant "B" was also an 18 month, low leakage design with standard fuel and part-length WABAs. Cycle 2 of plant "C" was a 12 month, low leakage design which fed OFA fuel following a first core with standard fuel. To further insure that the study was relevant to the Turkey Point units, several Turkey Point flux maps were chosen for comparison of reaction rate errors to the maps used in the study. The selection criteria for the Turkey Point flux maps are to select maps a) at various times in cycle life b) with at least 80% of thimbles used c) with 2D and 3D INCORE constants and d) from both units 3 & 4.

The following table describes the maps selected.

Case No.	Thim Used	Unit No.	Cycle No.	Map No.	Const Geom	Burnup (MWD/t)	Power (%HFP)
1	48	4	10	4	2D	1310	100
2	40	4	10	17	2D	11645	100
3	42	4	11	9	2D	4410	100
4	42	4	11	9	3D	4410	100
5	40	4	11	17	3D	8906	100
6	44	3	10	19	2D	9275	100

Table 1 contains the reaction rate errors from selected flux maps from the Turkey Point Units. The mean, variance, and standard deviation of

the reaction rate errors for each map are listed at the bottom of the table.

Table 2 contains the reaction rate errors from selected flux maps from the three-loop reload cores. The mean, variance, and standard deviation of the reaction rate errors for each map are listed at the bottom of the table. From this data it can be seen that the reaction rate errors for both the selected three-loop cores and the Turkey Point units are similar. The standard deviation for the Turkey Point units is [ ]$^{+}$ for the other three-loop reload cores. +a,c Therefore, the statistical analysis of peaking factor uncertainties from the three-loop study is applicable to the Turkey Point units.

Statistical Calculation of Peaking Factor Uncertainties

Three maps were taken from plant "A" and two each from plants "B" and "C" for a total of 7 different reference flux maps. Five separate deletion maps were run for each of the reference flux maps for a total of 35 deletions. The method used to remove thimbles was random. This random deletion method was shown to be valid in section I. Traces were deleted from the reference map until 50% of the available thimbles remained. This is a more conservative approach than deletion to just 50% of the total thimbles.

Data compiled from each flux map consists of a) the maximum measured $F_{\Delta H}$ and F_Q, b) the core average axial offset, c) the quadrant tilt (%) in the quadrant with the relative power furthest from 1.0, d) the minimum margin to F_Q*K(z) limit (expressed in percent), and e) the F_{xy} at the point of minimum F_Q*K(z) margin. Differences were calculated in terms of percentage changes in F_Q, $F_{\Delta H}$, and F_{xy} and relative difference in all other parameters using the following formulae:

$$\% \, Error_{TD} = (1 - F_{TD} / F_{Ref}) * 100 \qquad (1)$$

$$Error_{TD} = F_{Ref} - F_{TD} \qquad (2)$$

where "F_{TD}" is the parameter of interest from the deletion map, and "F_{Ref}" is the same parameter from the reference map with all available thimbles. This data is compiled in Table 3.

The mean difference and standard deviation for the five deletion cases for each map were then calculated, as were the mean and standard deviation for all reload maps combined (35 cases).

After all of these data were obtained, a 95%-confidence / 95%-probability one-sided upper tolerance limit was constructed to quantify the thimble deletion uncertainty component using the following formula:

$$TDUC = X_{comb} + kS_{comb} \qquad (3)$$

where "TDUC" is the thimble deletion uncertainty component for the parameter of interest ($F_{\Delta H}$, F_{xy}, or F_Q), "X_{comb}" is the mean $Error_{TD}$ for the parameter of interest for all 35 cases, "S_{comb}" is the mean standard deviation for the parameter of interest for all 35 cases, and "k" is the one-sided 95%-confidence / 95%-probability tolerance limit factor for the specific sample size. For 34 degrees of freedom (35 data points less 1), the value of "k" is 2.176. This data is listed in Table 4.

Table 5 contains the calculations for the total peaking factor uncertainties associated with only 50% of the thimbles being operational. The negative biases present in all of the data (negative meaning the deletion maps gave more conservative measurements) were ignored for conservatism. For all of these calculations, the uncertainty for the parameter of interest ($F_{\Delta H}$, F_{xy}, and F_Q) was combined with the statistically independent measurement uncertainties already in the Tech Specs using the following formula:

$$UNC = 1 + X_{comb} + SQRT((TSUC - 1)^2 + TDUC^2)) \qquad (4)$$

where "X_{comb}" is the mean $Error_{TD}$ for the parameter of interest (as calculated by equation 2) for all 35 cases, "TSUC" is the standard

Tech Spec uncertainty component (1.04 for $F_{\Delta H}$ and 1.05 for F_{xy} and F_Q), "TDUC" is calculated using Equation (3), and "SQRT" represents the square root function.

The resulting uncertainties for peaking factors with only 50% of thimbles operable are:

Peaking Factor Uncertainties
for Deletion to 50% of Thimbles

	TSUC	TDUC	Combined	Conservative
$F_{\Delta H}$	1.04	[	]+	1.05
F_{xy}	1.05			1.07
F_Q	1.05			1.07

+a,c

The TSUC and TDUC columns represent the Tech Spec and Thimble Deletion uncertainty components for the respective peaking factors. The "Combined" column is the statistically combined total uncertainty for the respective peaking factor (defined by equation 4). Two conservatisms were then added to the statistically combined uncertainties. The first conservatism rounds up the TDUC and the second doubles the rounded TDUC. The conservative value represents a conservative combination of the TSUC and TDUC. These conservatisms have no specific mathematical justification; they are to be used merely to allow for changing fuel management strategies and any extreme cases this study did not consider.

The variation in the measured axial offset and core quadrant tilts were calculated using the following formula:

$$\text{Variation} = X_{comb} \text{ +or- } kS_{comb}/\text{SQRT(Population)} \qquad (5)$$

These results are given in Table 6. As can be seen, deleting down to as few as 50% of the thimbles has little or no effect on the measured axial offset or core tilt when compared to the reference map. The variation for the axial offset is [ ]+ while the variation for the core tilt is [ ]+ +a,c +a,c

Summary

In the first section it was shown that the random INCORE instrumentation thimble deletion assumption was a valid one. Whether thimbles are deleted randomly or via 10-path device failure the results are the same. When deleting to 60% of the thimbles, the minimum number of thimbles that remain in any one quadrant is [ ]+ When deleting to 50% of the thimbles, the minimum number of thimbles that remain in any one quadrant is at least 3. +a,c

Although the data compiled for determining peaking factor uncertainties was not taken from the Turkey Point units, the second section showed that the data is applicable. Determination of peaking factor uncertainties remains unchanged from the previous memo (Reference 2). With down to 75% of the thimbles available for use, the standard Tech Specs require a 4% and 5% uncertainty on $F_{\Delta H}$ and F_Q respectively. With only 50% of the thimbles available, an additional 1% and 2% are added making the uncertainties for peaking factors 5% and 7% for $F_{\Delta H}$ and F_Q respectively. Within these uncertainties there are inherent conservatisms:

a) zeroing the negative values of X_{comb} in TDUC and UNC
b) rounding up $F_{\Delta H}$ and F_Q uncertainties
c) doubling the TDUC components of total $F_{\Delta H}$ and F_Q uncertainties

These peaking factor uncertainties are then applied to measurements using a ramp function as specified in the original thimble deletion study memo (Reference 2).

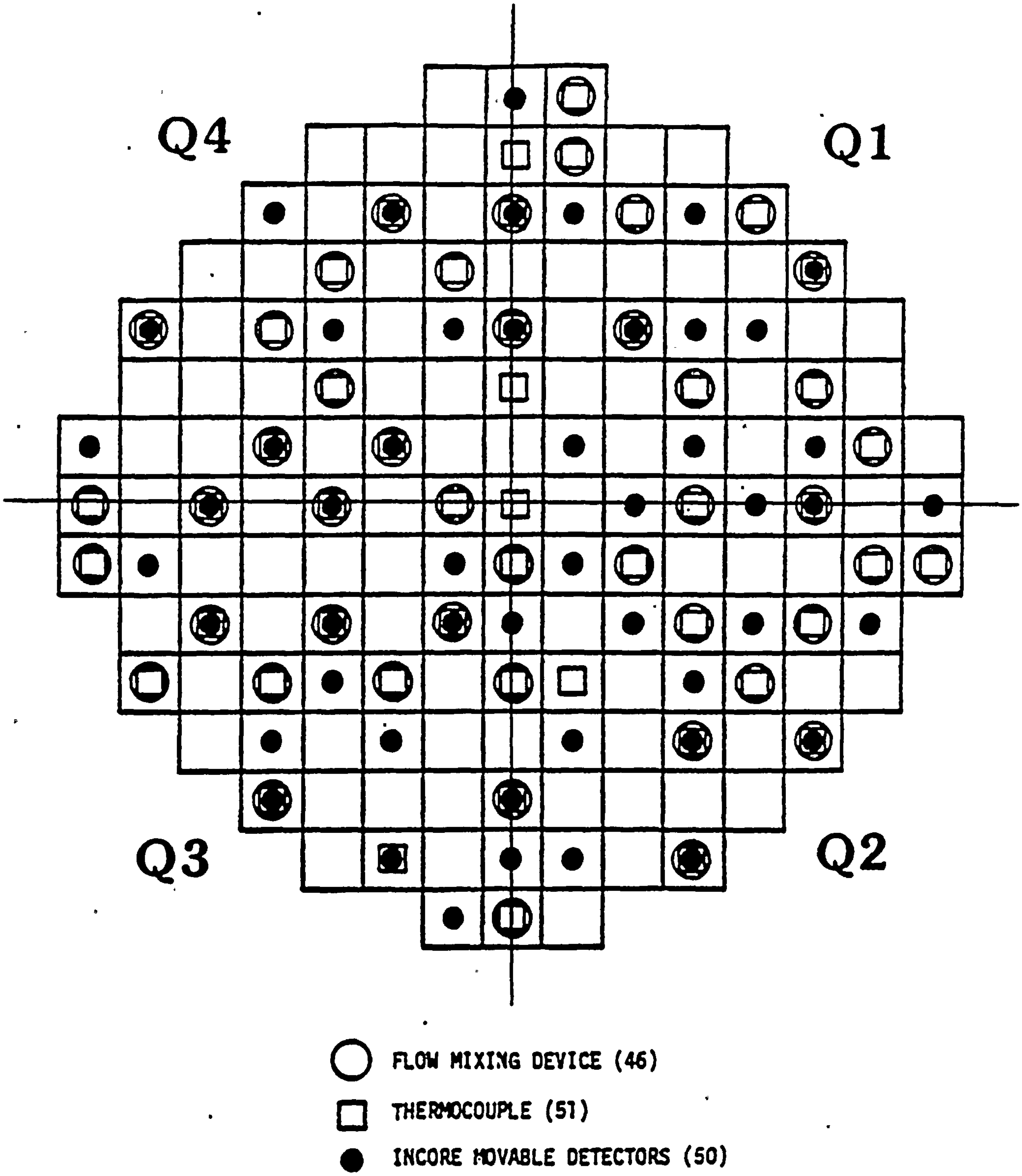
$$F_{\Delta H} \text{ measurement uncertainty} = 4\% + (1.0)*(3 - T/12.5)$$
$$F_Q \text{ measurement uncertainty} = 5\% + (2.0)*(3 - T/12.5)$$

where T is the number of operable thimbles remaining and must be between 25 and 37 inclusive. For cases with greater than 37 thimbles operable, the standard Tech Spec uncertainties apply.

[illegible]

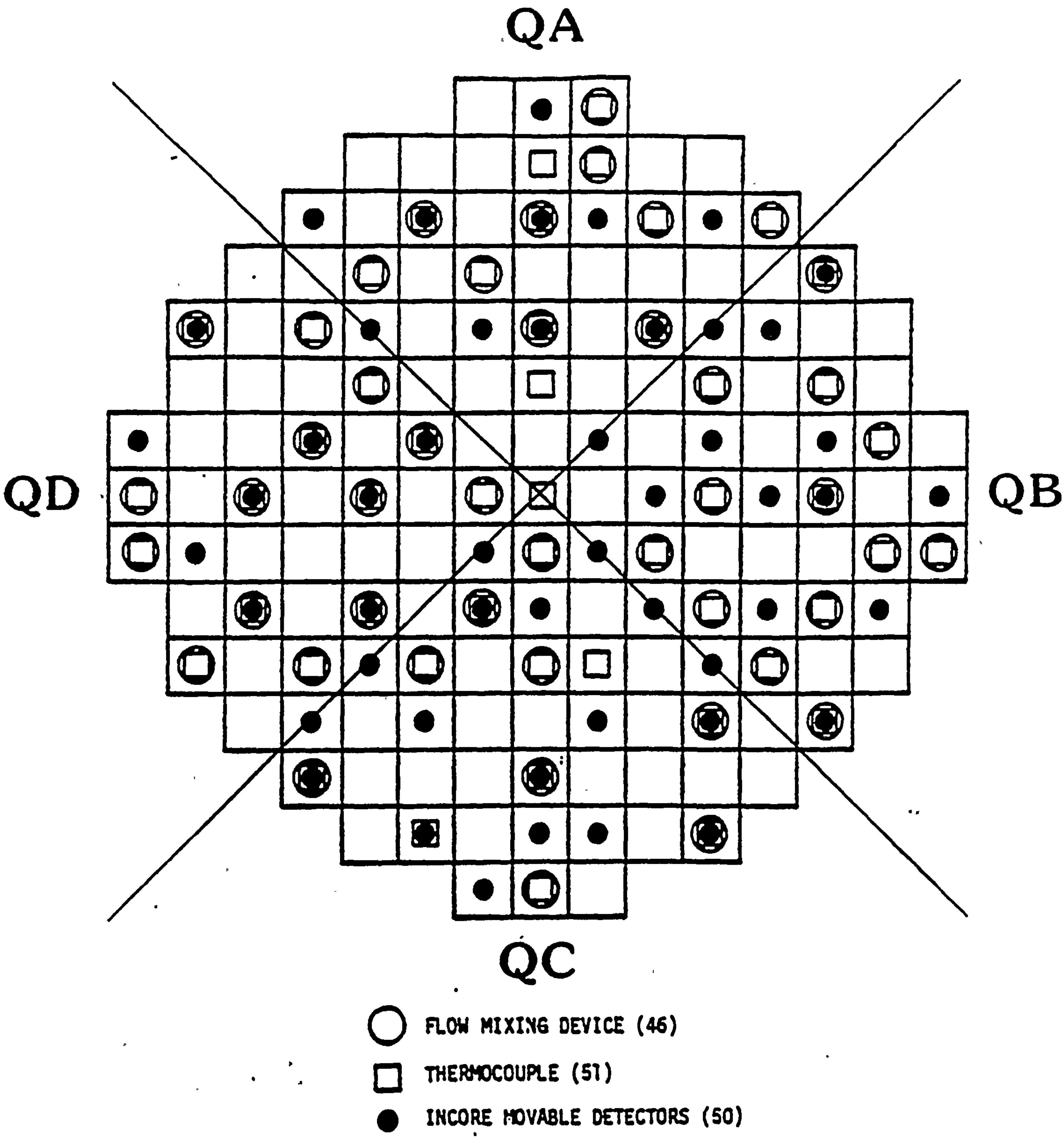
The information supplied here is merely a supplement to the original memo (Reference 2). The full scope of the this study is contained in the original memo. Because different data were used to analyze the peaking factor measurement uncertainties, all information in this memo supersedes that of the original memo. Attachment A includes the suggested Tech Spec changes that reflect the new peaking factor measurement uncertainties.

Figure 1



Core Quadrants Defined by the Horizontal and Vertical Axes

Figure 2



Core Quadrants Defined by the Diagonal Axes

Figure 3

PATH SELECTOR POSITION VS CORE POSITION

a,c

Table 1

Selected Turkey Point Units Flux Maps
Reaction Rate Errors

a, c

Table 2

Selected Three-Loop Reload Flux Maps
Reaction Rate Errors

a,c

Table 3

Flux Map Results for Three-Loop Cores

a,c

Table 4

Statistical Results for All Deletion Maps

a,c

Table 5

Calculation of Uncertainties for 50% of Available Thimbles

$F_{\Delta H}$ Uncertainty:

$$UNC(F_{\Delta H}) = 1 + X_{comb} + SQRT((UNC* - 1)^2 + TDUC^2))$$

[ ] a,c

F_{xy} Uncertainty:

$$UNC(F_{xy}) = 1 + X_{comb} + SQRT((UNC* - 1)^2 + TDUC^2))$$

[ ] a,c

F_Q Uncertainty:

$$UNC(F_Q) = 1 + X_{comb} + SQRT((UNC* - 1)^2 + TDUC^2))$$

[ ] a,c

Table 6

Calculation of Variability for 50% of Available Thimbles

Axial Offset:

Variation = [ ] a,c
=

Quadrant Tilt:

Variation = [ ] a,c
=

[illegible]

Attachment A

Insert A: When the number of operable moveable detector thimbles (T) is less than 75% of the total, the 5% F_Q measurement uncertainty shall be increased to [5% + (2.0)(3 - T/12.5)] where T (the number of operable t' imbles), must be greater than or equal to 50% of the total.

Insert B: When the number of operable moveable detector thimbles (T) is less than 75% of the total, the 4% $F_{\Delta H}$ measurement uncertainty shallbe increased [4% + (1.0)(3 - T/12.5)] where T (the number of operable thimbles), must be greater than or equal to 50% of the total.

Insert C: A minimum of three (3) detector thimbles per core quadrant where two sets of quadrants are defined: 1) quadrants formed by the vertical and horizontal axes of the core and 2) quadrants formed by the two diagonals of the core. These quadrants are defined such that the instrumented locations along the axes dividing the quadrants are included in each of those adjacent quadrants as whole thimbles.

Insert D: At least 90% of the detector thimbles must be operable at the beginning of cycle.

Attachment A
(continued)

Insert E: U_{BL} is defined as the Base Load uncertainty factor that accounts for: manufacturing tolerance, measurement error, rod bow and any burnup and power dependent peaking factor increases. With at least 75% of the detector thimbles operable, U_{BL} is 9%. When the number of operable moveable detector thimbles (T) is less than 75% of the total, the U_{BL} uncertainty factor shall be increased to:

$$[9\% + (2.0)(3 - T/12.5)]$$

where T (the number of operable thimbles), must be greater than or equal to 50% of the total.

Insert F: U_{RB} is defined as the Radial Burndown uncertainty factor that accounts for: manufacturing tolerance, measurement error, rod bow and any burnup and power dependent peaking factor increases. With at least 75% of the detector thimbles operable, U_{RB} is 9%. When the number of operable moveable detector thimbles (T) is less than 75% of the total, the U_{RB} uncertainty factor shall be increased to:

$$[9\% + (2.0)(3 - T/12.5)]$$

where T (the number of operable thimbles), must be greater than or equal to 50% of the total.

3/4.2.2 HEAT FLUX HOT CHANNEL FACTOR - $F_Q(Z)$

LIMITING CONDITION FOR OPERATION

3.2.2 $F_Q^M(Z)$ shall be limited by the following relationships:

$$F_Q^M(Z) \leq \frac{[F_Q]^L}{P} \times [K(Z)] \text{ for } P > 0.5$$

$$F_Q^M(Z) \leq \frac{[F_Q]^L}{0.5} \times [K(Z)] \text{ for } P \leq 0.5$$

where: $[F_Q]^L = 2.32$

$$P = \frac{\text{Thermal Power}}{\text{Rated Thermal Power}}$$

and K(Z) is the function obtained from Figure 3.2-2 for a given core height location.

APPLICABILITY: MODE 1

ACTION:

With the measured value of $F_Q(Z)$ exceeding its limit:

a. Reduce THERMAL POWER at least 1% for each 1% $F_Q^M(Z)$ exceeds $F_Q^L(Z)$ within 15 minutes and similarly reduce the Power Range Neutron Flux - High Trip Setpoints within the next 4 hours; POWER OPERATION may proceed for up to a total of 72 hours; subsequent POWER OPERATION may proceed provided the Overpower Delta-T Trip Setpoints (value of K_4) have been reduced at least 1% for each 1% $F_Q^M(Z)$ exceeds the limit; and

b. Identify and correct the cause of the out-of-limit condition prior to increasing THERMAL POWER above the reduced power limit required by ACTION a., above; THERMAL POWER may then be increased provided $F_Q^M(Z)$ is demonstrated through incore mapping to be within its limit.

SURVEILLANCE REQUIREMENTS

4.2.2.1 If $[F_Q]^P$ as predicted by approved physics calculations is greater than $[F_Q]^L$ and P is greater than P_T as defined in 4.2.2.2, $F_Q(Z)$ shall be evaluated by 4.2.2.2, 4.2.2.3 or 4.2.2.4 to determine if F_Q is within its limit. If $[F_Q]^P$, is less than $[F_Q]^L$ or P is less than P_T, $F_Q(Z)$ shall be evaluated to determine if $F_Q(Z)$ is within its limit as follows:

a. Using the movable incore detectors to obtain a power distribution map at any THERMAL POWER greater than 5% of RATED THERMAL POWER.

b. Increasing the measured $F_Q(Z)$ component of the power distribution map by 3% to account for manufacturing tolerances and further increasing the value by 5% to account for measurement uncertainties. Verifying that the requirements of Specification 3.2.2. are satisfied.

INSERT A:

c. $F_Q^M(Z) \leq F_Q^L(Z)$

Where $F_Q^M(Z)$ is the measured $F_Q(Z)$ increased by the allowances for manufacturing tolerances and measurement uncertainty and $F_Q^L(Z)$ is the F_Q limit defined in 3.2.2.

[illegible]

[illegible]

d. Measuring $F_Q^M(Z)$ according to the following schedule:

1. Prior to exceeding 75% of RATED THERMAL POWER*, after refueling,

2. At least once per 31 Effective Full Power Days.

e. With the relationship specified in Specification 4.2.2.1.c above not being satisfied:

1) Calculate the percent $F_Q^M(Z)$ exceeds its limit by the following expression:

$$\left[\begin{matrix}\text{Maximum}\\ \text{Over } Z\end{matrix}\left[\frac{F_Q^M(Z)}{[F_Q]^L \times K(Z)/P}\right] - 1\right] \times 100 \text{ for } P \geq 0.5$$

$$\left[\begin{matrix}\text{Maximum}\\ \text{Over } Z\end{matrix}\left[\frac{F_Q^M(Z)}{[F_Q]^L \times K(Z)/0.5}\right] - 1\right] \times 100 \text{ for } P < 0.5$$

* During power escalation at the beginning of each cycle, power level may be increased until a power level for extended operation has been achieved and power distribution map obtained.

2) The following action shall be taken:

a) Comply with the requirements of Specification 3.2.2 for $F_Q^M(Z)$ exceeding its limit by the percent calculated above.

4.2.2.2 Operation is permitted at power above P_T where P_T equals the ratio of $[F_Q]^L$ divided by $[F_Q]^P$ if the following Augmented Surveillance (Movable Incore Detection System, MIDS) requirements are satisfied:

a. The axial power distribution shall be measured by MIDS when required such that the limit of $[F_Q]^L/P$ times Figure 3.2.2 is not exceeded. $F_j(Z)$ is the normalized axial power distribution from thimble j at core elevation (Z).

1. If $F_j(Z)$ exceeds $[F_j(Z)]_S$ as defined in the bases by $\leq$ 4%, immediately reduce thermal power one percent for every percent by which $[F_j(Z)]_S$ is exceeded.

2. If $F_j(Z)$ exceeds $[F_j(Z)]_S$ by > 4% immediately reduce thermal power below P_T. Corrective action to reduce $F_j(Z)$ below the limit will permit return to thermal power not to exceed current P_L as defined in the bases.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

SURVEILLANCE REQUIREMENTS (Continued)

b. $F_j(Z)$ shall be determined to be within limits by using MIDS to monitor the thimbles required per specification 4.2.2.2.c at the following frequencies.

1. At least once every 24 hours, and

2. Immediately following and as a minimum at 2, 4 and 8 hours following the events listed below and every 24 hours thereafter.

    1) Raising the thermal power above P_T, or

    2) Movement of control-bank D more than an accumulated total of 15 steps in any one direction.

c. MIDS shall be operable when the thermal power exceeds P_T with:

1. At least two thimbles available for which $\bar{R}_j$ and σ_j as defined in the bases have been determined.

2. At least two movable detectors available for mapping $F_j(Z)$.

3. The continued accuracy and representativeness of the selected thimbles shall be verified by using the most recent flux map to update the $\bar{R}$ for each selected thimble. The flux map must be updated at least once per 31 effective full power days.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

SURVEILLANCE REQUIREMENTS (Continued)

4.2.2.3 Base Load operation is permitted at powers above P_T if the following requirements are satisfied:

a. Either of the following preconditions for Base Load operation must be satisfied.

1. For entering Base Load operation with power less than P_T,

a) Maintain THERMAL POWER between $P_T/1.05$ and P_T for at least 24 hours,

b) Maintain the AFD (Delta-I) to within a ± 2% or ± 3% target band for at least 23 hours per 24 hour period.

c) After 24 hours have elapsed, take a full core flux map to determine $F_Q^M(Z)$ unless a valid full core flux map was taken within the time period specified in 4.2.2.1d.

d) Calculate P_{BL} per 4.2.2.3b.

2. For entering Base Load operation with power greater than P_T,

a) Maintain THERMAL POWER between P_T and the power limit determined in 4.2.2.2 for at least 24 hours, and maintain Augmented Surveillance requirements of 4.2.2.2 during this period.

b) Maintain the AFD (Delta-I) to within a ± 2% or ± 3% target band for at least 23 hours per 24 hour period,

[illegible]

c) After 24 hours have elapsed, take a full core flux map to determine $F_Q^M(Z)$ unless a valid full core flux map was taken within the time period specified in 4.2.2.1d.

d) Calculate P_{BL} per 4.2.2.3b.

b. Base Load operation is permitted provided:

1. THERMAL POWER is maintained between P_T and P_{BL} or between P_T and 100% (whichever is most limiting).

2. AFD (Delta-I) is maintained within a ± 2% or ± 3% target band.

3. Full core flux maps are taken at least once per 31 effective Full Power Days.

P_{BL} and P_T are defined as:

$$P_{BL} = \underset{\text{Over } Z}{\text{Minimum}} \left[\frac{[F_Q]^L \times K(Z)}{F_Q^M(Z) \times W(Z)_{BL} \times \cancel{1.09}\ U_{BL}} \right]$$

$$P_T = [F_Q]^L / [F_Q]^P$$

where: $F_Q^M(Z)$ is the measured $F_Q(Z)$ with no allowance for manufacturing tolerances or measurement uncertainty. For the purpose of this Specification $[F_Q(Z)]_{Map}$ Meas. shall be obtained between elevations bounded by 10% and 90% of the active core height. $[F_Q]^L$ is the F_Q limit. K(Z) is given in Figure 3.2-2. $W(Z)_{BL}$ is the cycle dependent function that accounts for limited power distribution transients encountered during base load operation.

The function is given in the Peaking Factor Limit Report as per Specification 6.9.1.6. ~~The 9% uncertainty factor accounts for manufacturing tolerance, measurement error, rod bow and any burnup and power dependent peaking factor increases.~~

INSERT E

c. During Base Load operation, if the THERMAL POWER is decreased below P_T, then the conditions of 4.2.2.3.a shall be satisfied before re-entering Base Load operation.

d. If any of the conditions of 4.2.2.3b are not maintained, reduce THERMAL POWER to less than or equal to P_T, or, within 15 minutes initiate the Augmented Surveillance (MIDS) requirements of 4.2.2.2.

4.2.2.4 Operation is permitted at powers above P_T if the following Radial Burndown conditions are satisfied:

a. Radial Burndown operation is restricted to use at powers between P_T and P_{RB} or P_T and 1.00 (whichever is most limiting). The maximum relative power permitted under Radial Burndown operation, P_{RB}, is equal to the minimum value of the ratio of $[F_Q^L(Z)]/[F_Q(Z)]_{RB}$ Meas. where:

$[F_Q(Z)]_{RB}$ Meas. = $[F_{xy}(Z)]_{Map}$ Meas. x $F_z(Z)$ x ~~1.09~~ U_{RB} and

$[F_Q^L(Z)]$ is equal to $[F_Q^L]$ x $K(Z)$.

b. A full core flux map to determine $[F_{xy}(Z)]_{Map}$ Meas. shall be taken within the time period specified in Section 4.2.2.1d.2. For the purpose of the specification, $[F_{xy}(Z)]_{Map}$ Meas. shall be obtained between the elevations bounded by 10% and 90% of the active core height.

[illegible]

SURVEILLANCE REQUIREMENTS (Continued)

c. The function $F_Z(Z)$, provided in the Peaking Factor Limit Report (6.9.1.6), is determined analytically and accounts for the most perturbed axial power shapes which can occur under axial power distribution control. ~~The uncertainty factor of 9% accounts for manufacturing tolerances, measurement error, rod bow, and any burnup dependent peaking factor increases.~~

— INSERT EF

d. Radial Burndown operation may be utilized at powers between P_T and P_{RB}, or, P_T and 1.00 (whichever is most limiting) provided that the AFD (Delta-I) is within ± 5% of the target axial offset.

e. If the requirements of Section 4.2.2.4d are not maintained, then the power shall be reduced to less than or equal to P_T, or within 15 minutes Augmented Surveillance of hot channel factors shall be initiated if the power is above P_T.

4.2.2.5 When $F_Q(Z)$ is measured for reasons other than meeting the requirements of specification 4.2.2.1, 4.2.2.2, 4.2.2.3 or 4.2.2.4 an overall measured $F_Q(Z)$ shall be obtained from a power distribution map and increased by 3% to account for manufacturing tolerances and further increased by 5% to account for measurement uncertainty.

— INSERT A:

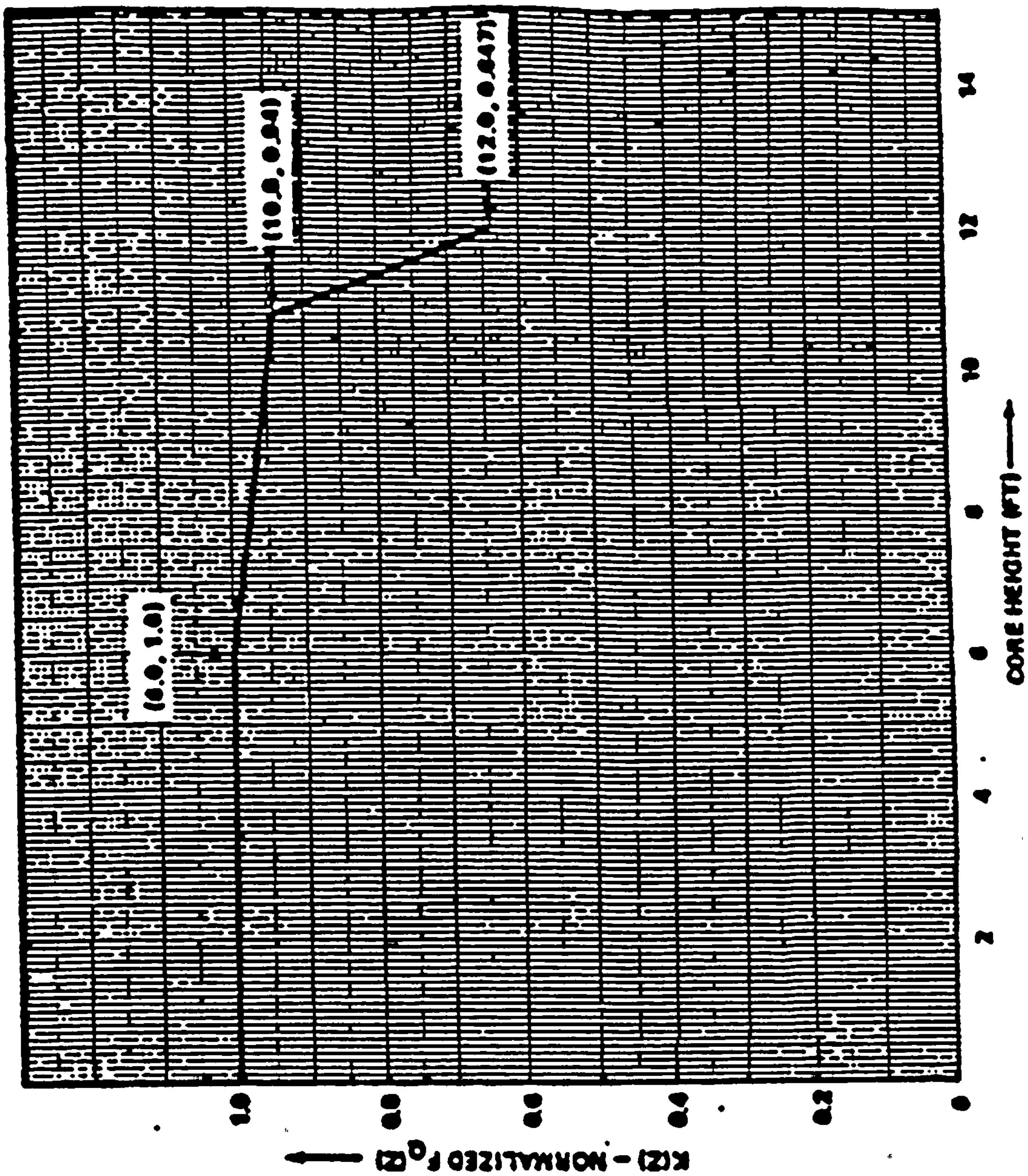


FIGURE 3.2-2
K(Z) Normalized $F_Q(Z)$ as a Function of Core Height

3/4.2.3 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR

LIMITING CONDITION FOR OPERATION

3.2.3 $F^N_{\Delta H}$ Shall be limited to the following:

$$F^N_{\Delta H} \leq 1.62\ [1.0 + 0.3(1-P)],\ \text{where}$$

$$P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

APPLICABILITY: MODE 1.

ACTION:

With $F^N_{\Delta H}$ exceeding its limit:

a. Within 2 hours reduce THERMAL POWER to less than 50% of RATED THERMAL POWER and reduce the Power Range Neutron Flux - High Trip Setpoint to less than or equal to 55% of RATED THERMAL POWER within the next 4 hours.

b. Within 24 hours of initially being outside the above limits, verify through incore flux mapping that $F^N_{\Delta H}$ is restored to within the above limit, or reduce THERMAL POWER to less than 5% of RATED THERMAL POWER within the next 2 hours.

c. Identify and correct the cause of the out-of-limit condition prior to increasing THERMAL POWER above the reduced THERMAL POWER limit required by ACTION a. and/or b., above; subsequent POWER OPERATION may proceed provided that $F^N_{\Delta H}$ is demonstrated, through incore flux mapping, to be within its limit of acceptable operation prior to exceeding the following THERMAL POWER levels:

   1. A nominal 50% of RATED THERMAL POWER,

   2. A nominal 75% of RATED THERMAL POWER, and

   3. Within 24 hours of attaining greater than or equal to 95% of RATED THERMAL POWER.

SURVEILLANCE REQUIREMENTS

4.2.3.1 The provisions of Specification 4.0.4 are not applicable.

4.2.3.2 $F^N_{\Delta H}$ shall be determined to be within its limit through incore flux mapping:

a. Prior to operating above 75% of RATED THERMAL POWER after each fuel loading, and

b. At least once per 31 Effective Full Power Days.

4.2.3.3 The measured $F^N_{\Delta H}$ shall be increased by 4% to account for measurement error.

INSERT B:

INSTRUMENTATION

MOVABLE INCORE DETECTORS

LIMITING CONDITION FOR OPERATION

3.3.3.2 The movable Incore Detection System shall be OPERABLE with:

a. At least ~~75%~~ 50% of the detector thimbles,

~~b. A minimum of two detector thimbles per core quadrant, and~~

INSERT C

c. Sufficient movable detectors, drive, and readout equipment to map these thimbles.

INSERT D

APPLICABILITY: When the Movable Incore Detection System is used for:

a. Recalibration of the Excore Neutron Flux Detection System, or

b. Monitoring the QUADRANT POWER TILT RATIO, or

c. Measurement of $F_{\Delta H}^{N}$ and $F_Q(Z)$

ACTION:

With the Movable Incore Detection System inoperable, do not use the system for the above applicable monitoring or calibration functions. The provisions of Specifications 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.3.2 The Movable Incore Detection System shall be demonstrated OPERABLE at least once per 24 hours by normalizing each detector output when required for:

a. Recalibration of the Excore Neutron Flux Detection System, or

b. Monitoring the QUADRANT POWER TILT RATIO, or

c. Measurement of $F_{\Delta H}^{N}$ and $F_Q(Z)$

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