Appendix C

# Westinghouse Thimble Reduction Study for Turkey Point Units 3 and 4

(Non-Proprietary Version)

Westinghouse Class 3

# Thimble Reduction Study for Turkey Point Units 3 and 4

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[illegible]

## Introduction

This report documents a study performed for the Florida Power and Light Turkey Point Units 3 and 4, to address the issue of operating with less than 75% of the 50 total instrumentation thimbles in the core. The main objective of this analysis was to determine the additional peaking factor measurement uncertainty that should be applied and addresses the NRC concerns when fewer than 75% of the instrumentation thimbles are operational. The study is based on previous studies of a similar nature where removal of more than 75% of the operable thimbles was desired. Because of the nature of the problem this study is statistical in nature, and an exact answer cannot be defined. The following pages describe the methodology used for the study and recommendations for applying the results.

## History

Studies similar to this have been generated for other operating plants with tech specs requiring more than 75% of the instrumentation thimbles operational. However, no permanent technical specification change allowing a reduced number of operable instrumentation thimbles has been approved by the Nuclear Regulatory Commission. Attached is the NRC Safety Evaluation Report in response to a submittal prepared by Westinghouse. This SER states several concerns regarding the reduction of operating instrumentation thimbles in the core (less than 75%) during normal plant operations. A temporary tech spec change has been granted for a current operating cycle based on the submittal; however, a permanent tech spec change has not been granted because of the concerns addressed in the attached SER.

It is the intent of this study to satisfy these concerns in this regard in order to obtain a permanent tech spec change. The two main issues from this SER are:

1) Permanent change of the tech spec would lead to decreased level of Moveable Incore Detector System (MIDS) system maintenance.

2) The ability of the MIDS system to detect anomalies in cases with large portions of the core uninstrumented would be unacceptable.

The following explains how the above concerns may be addressed; however, other concerns relating to thimble reduction may exist that are not known at this time.

## Peaking Factor Uncertainties

Several studies have been done with peaking factor measurement uncertainties when less than the full complement of instrumentation thimbles are used in the core. These studies were used as a basis for determining the magnitude of the uncertainty to be applied to measured peaking factors for the Turkey Point Units.

To determine the additional uncertainty in measurement of peaking factors, three full power core power distribution maps were used for reference. Five separate random thimble reduction cases (down to 50%

of the thimbles) were done for each map -- a total of 15 reduced maps. The measured peaking factors in the deleted maps were then compared to the reference maps (with all 50 thimbles). The additional measurement uncertainties for 50% of the thimbles were determined from these comparisons. Uncertainties were calculated for $F_{\Delta H}$ and $F_Q$ and the effects of thimble deletion on the axial offset and quadrant tilt were also assessed.

As a result of these calculations an additional measurement uncertainty of [ ] was determined for $F_{\Delta H}$, and an additional measurement uncertainty of [ ] was determined for $F_Q$. These values were conservatively rounded to 1.0% for $F_{\Delta H}$ and 2.0% for $F_Q$. As an additional conservatism these values are doubled to 2.0% for $F_{\Delta H}$ and 4.0% for $F_Q$. These are the maximum additional measurement uncertainties for $F_{\Delta H}$ and $F_Q$ with 50% of the instrumentations thimbles removed. Current standard Tech Specs define the uncertainties at 75% of thimbles remaining as 4.0% for $F_{\Delta H}$ and 5.0% for $F_Q$. Therefore, the total uncertainty in measurement of peaking factors with more than 75% of the thimbles removed can be described by the functions as follows: +a,c +a,c

$$F_{\Delta H} \text{ measurement uncertainty} = 4\% + (2)*(3 - T/12.5)$$

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

where T is the number of operable thimbles remaining and must be between 25 and 37 thimbles, inclusive. For cases with greater than 37 thimbles operable, the standard Tech Spec uncertainties apply (4.0% for $F_{\Delta H}$ and 5.0% for $F_Q$).

Although these uncertainties apply to removal of up to 50% of the thimbles, a base thimble limit can be set. This limit would be a minimum number of thimbles (greater than or equal to 25) that must remain operable. This is the same as having a maximum number of thimbles (less than or equal to 25) that can be removed from operation. The purpose of this limit is to address the concern that large areas of the core would be uninstrumented.

The next section discusses the base thimble limit association with the minimum number of thimbles per quadrant. A higher base limit results in a theoretically greater number of thimbles per quadrant. And a higher number of minimum thimbles per quadrant results in smaller areas of the core being uninstrumented.

The impact of thimble reduction on axial power offset and quadrant tilt is negligible. Studies have shown that the difference between reduced thimble maps and the reference maps is equal to or less than [ ] for axial power offset and [ ] for quadrant tilt. +a,c +a,c

Minimum Thimble Requirement Per Quadrant

The peaking factor measurement uncertainty analysis described above makes the assumption that thimbles were randomly deleted from the core. If thimbles are somehow systematically deleted from the core then the above calculated peaking factor measurement uncertainties will not apply. This section describes the calculations performed to establish

a criteria for determining whether elimination of instrumentation thimbles from the flux mapping system is random or systematic and also determines the bounds of applicability of the incremental peaking factor uncertainties.

Both Turkey Point units (3 and 4) have a total of 50 instrumentation thimbles. A basic assumption of the peaking factor uncertainties documented in the previous section is that the removal of operable thimbles from the core is random in nature. The following defines exactly what random deletions means in term of the peaking factor uncertainty.

The assumption of random deletion of thimbles is an important one. If removal of instrumentation thimbles in the core is completely random then each thimble in the core has an equal probability of being removed from operation. Therefore, if 50 percent of the thimbles in the core were to be deleted randomly, a random pattern of thimbles would result. On the other hand, if there were some function driving the removal of the thimbles the result would not be a random pattern of thimbles. This systematic deletion of thimbles could conceivably result in large areas of the core being uninstrumented. If this would occur the peaking factor uncertainties would no longer be applicable.

To help insure that thimble deletion is random, a restriction can be placed on the number of thimbles that must remain operable in each quadrant. For example, if 50% of the thimbles were randomly removed from the core, it can be shown that [ ] of the time at least three(3) thimbles will be remaining in each quadrant of the core. If less than three(3) thimbles remain in any quadrant a systematic deletion would be suspected and the peaking factor uncertainties could not be applied. +a,c

To determine the minimum number of thimbles that will remain per quadrant in a random deletion a small computer simulation code was written to arrive at a statistical solution. The core was divided into two sets of quadrants as depicted in Figures 1 and 2. Figure 1 shows the core divided into four sections by cutting it north to south and east to west. This will be referred to as quadrants Q1 through Q4. Figure 2 shows the core divided along the diagonals to form four sections; these quadrants will be referred to as QA through QD. What this accomplishes is to basically divide the core into eight octants using two sets of four quadrants each. These quadrants are all defined such that the assemblies along the axes dividing the quadrants are included in each of those adjacent quadrants.

The object of the computer simulation is to determine the minimum number of thimbles remaining in any one of these quadrants for a given percentage of the thimbles deleted. The program randomly deletes a specified percentage of the total number of thimbles from the pattern of thimble locations shown in Figures 3 and 4. The resulting pattern is then analyzed to determine the minimum number of thimbles remaining in any of the eight quadrants defined above.

The computer simulation was run for deletions of 60% and 50% of the thimbles with 5000 cases for each simulation. The results are tabulated in Table 1. [ ]+a,c

[ ] a,c

In summary, when 50% of the thimbles remain after a random deletion, at least three(3) thimbles should be left in each of the eight quadrants. If less than three thimbles are left in any quadrant, then the thimble removal is probably not a random process and the peaking factor uncertainties calculated previously will no longer apply. [ ] a,c of the total number of thimbles was not random; the peaking factor uncertainties no longer apply.

Minimum Thimble Requirement at Cycle Startup

One of the NRC's main concerns was that a procedure for reducing the minimum number of operable thimbles would lead to reduced maintenance of the MIDS. To alleviate this concern an initial startup criteria can be added to the requirements. This would require that a minimum number of thimbles (90% for example) must be operable at the start of a cycle. This would assure adequate maintenance of the MIDS.

Conclusions

Using the additional peaking factor measurement uncertainties and requirements for minimum number of thimbles remaining per quadrant will provide a procedure acceptable for operation of the MIDS with 50% or greater of the thimbles. However, no permanent Tech Spec change has been granted allowing a reduced number (less than 75%) of operable instrumentation thimbles.

Recommendations

In summary, the following recommendations are made to address the technical aspects of thimble reduction as well as the concerns of the NRC which have been voiced in the past. These recommendations are as follows:

1) Peaking factor uncertainties: Additional measurement uncertainties should be applied to both $F_{\Delta H}$ and $F_Q$. These uncertainties are applied in the form of the following equations:

$$F_{\Delta H}^U = 2 * (3 - T/12.5) + 4.0$$
$$F_Q^U = 4 * (3 - T/12.5) + 5.0$$

where T is the number of operable thimbles remaining. And T must between 25 (50%) and 37 (74%) inclusive. The uncertainties are expressed in percent and include the nominal uncertainties.

[illegible]

2) Base thimble limit: A minimum percentage of thimbles remaining must be set. This study provides the ability to set the base thimble limit to 50%. However, the higher the base limit is, the less concern regarding uninstrumented areas of the core.

3) Minimum number of thimbles per quadrant: In order to apply the peaking factor uncertainties a minimum number of thimbles must be in each quadrant. This minimum is dependent on the base limit set above. For a 50% base limit the minimum number of thimbles per quadrant is three.

4) Startup minimum thimble limit: To address the concern for reduced incentive of MIDS maintenance at startup, a minimum thimble limit should be applied. This limit would require that a minimum number of thimbles (90% for example) be operable at the start up of each cycle. A major problem with reduced MIDS maintenance is the inability of the system (with a large reduction in operable thimbles) to detect misloaded assemblies at the beginning of a fuel cycle. Since the peaking factor measurement uncertainties calculated in this study assume a normal power distribution map as a reference, the issue of misloaded assemblies is not specifically addressed. The minimum thimble limit at startup would resolve this concern.

Since MIDS is not a continuous on-line core monitoring system, nor is it a safety grade protection system it is the Westinghouse position that its use in detecting or analyzing abnormal core conditions is a secondary function of the system. Its primary function is the verification of measured versus predicted core parameters on a periodic basis. Since the philosophy behind the purpose of the MIDS is debatable, the above recommendations may not satisfy the NRC concerns regarding licensing of the system below 75% of the thimbles operational.

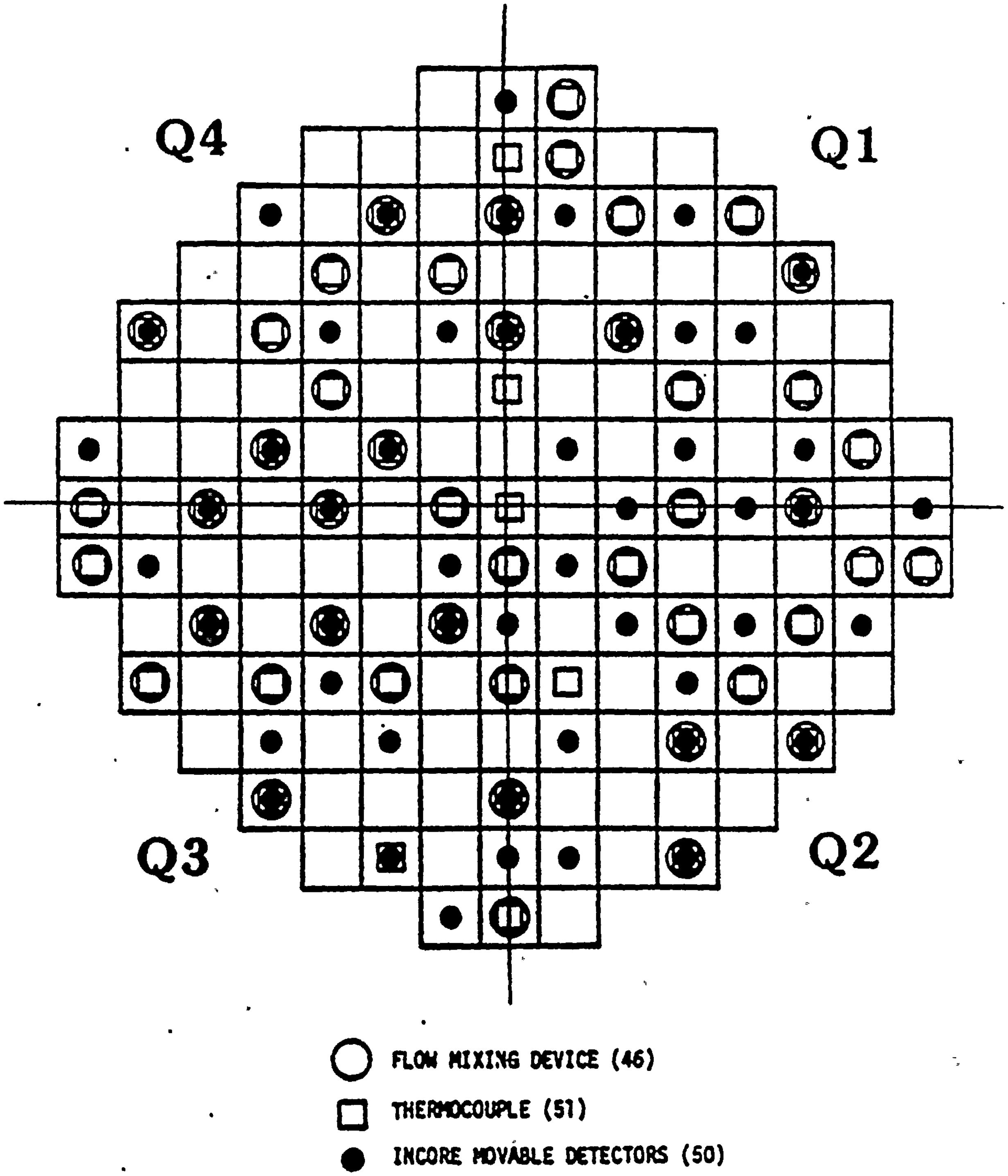
Table 1

Three Loop Core Geometry

Turkey Point Units 3 and 4

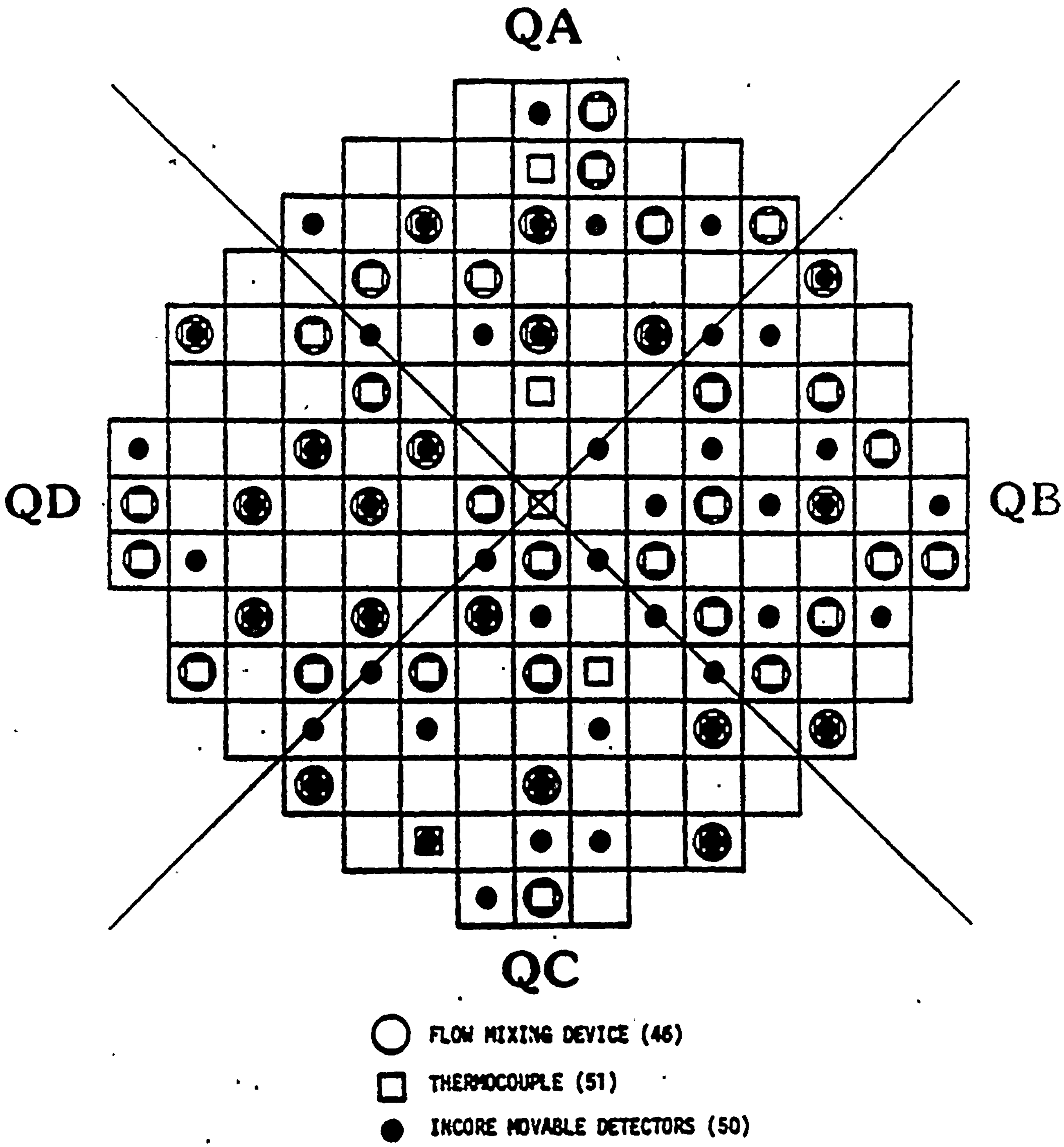
a,c

# Figure 1




Core Quadrants Defined by the Horizontal and Vertical Axes

# Figure 2




Core Quadrants Defined by the Diagonal Axes

Attachment 1

NRC SER on Incore Detector Thimble Reduction Study

[illegible]

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION REPORT

OFFICE OF NUCLEAR REACTOR REGULATION

INCORE DETECTOR THIMBLE DELETION STUDY

## INTRODUCTION

In a letter dated December 16, 1982, Proposed Change Request No.75 to the Operating License of Power Station, Unit No. 1. The request proposed to reduce the number of thimbles required by the Technical Specifications to 50% from 75% for the incore movable detector system to be operable.

The licensee provided documentation in letters dated January 4, 1983 and February 24, 1983 supporting an increase of the movable incore detector map measurement uncertainty as part of the change request. By Amendment No. 61 dated January 19, 1983, we provided interim approval of the proposed Technical Specification change request for the remainder of the then operating Cycle 3. Our intention was to complete the review of the subject report.

## EVALUATION

Essentially all PWR Technical Specifications contain a requirement for operability of 75% of the incore detector locations for periodic mapping of the core power distribution. On a number of occasions, for various reasons, failures in operating PWRs have approached or exceeded 25%, and relaxation of the 75% requirement has been permitted for the duration of affected reactor cycles. This has generally been allowed either with increased surveillance of some sort (such as increased frequency of mapping) or, as in the case of the interim approval of this change for Cycle 3 of Unit 1, when there is substantial margin to Technical Specification peaking factor limits.

We advocate maintenance of as close to 100% operability of the incore detector system as is possible. We believe that this is required to be able to identify and evaluate possible power distribution or reactivity anomalies which might occur during the operation of power plants. An example is the burnable poison rod leaching problem that occurred in St. Lucie 1 where the incore instrumentation was essential in identifying and understanding the problem.

The 75% operability requirement was chosen to allow a reasonable amount of failures of the incore detectors, but to encourage the licensees to strive for as near to 100% as possible. Permanent Technical Specification changes to reduce the number to 50% might result in a lack of incentive to keep the system operating as close to 100% as possible. This could result in an unacceptably degraded ability to detect anomalous conditions in the core.

We therefore conclude that a permanent change of the Unit 1 Technical Specifications to allow operation with up to 50% of the incore detector thimbles failed is not acceptable. In the event that the operability requirement of 75% cannot be met during a cycle, we will consider interim Technical Specifications for the remainder of a cycle, as has been done before. Consideration would be given to available resulting margin from reduction of operating peaking factors with cycle burnup, application of additional measurement uncertainties, and more frequent incore mapping.

<u>Date</u>: August 29, 1983

<u>Principal Contributor</u>:

M. Dunenfeld

Attachment 2

Sample Technical Specification Modifications

[illegible]

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% + (4)(3 - T/12.5)] where T (the number of operable thimbles), 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 shall be increased to [4% + (2)(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.

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% + (4)(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% + (4)(3 - T/12.5)]

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

[illegible]

## 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.

[illegible]

POWER DISTRIBUTION LIMITS

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.

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:

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

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

* 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.

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 $\sigma_j$ 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]

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.

[illegible]

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 F

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:

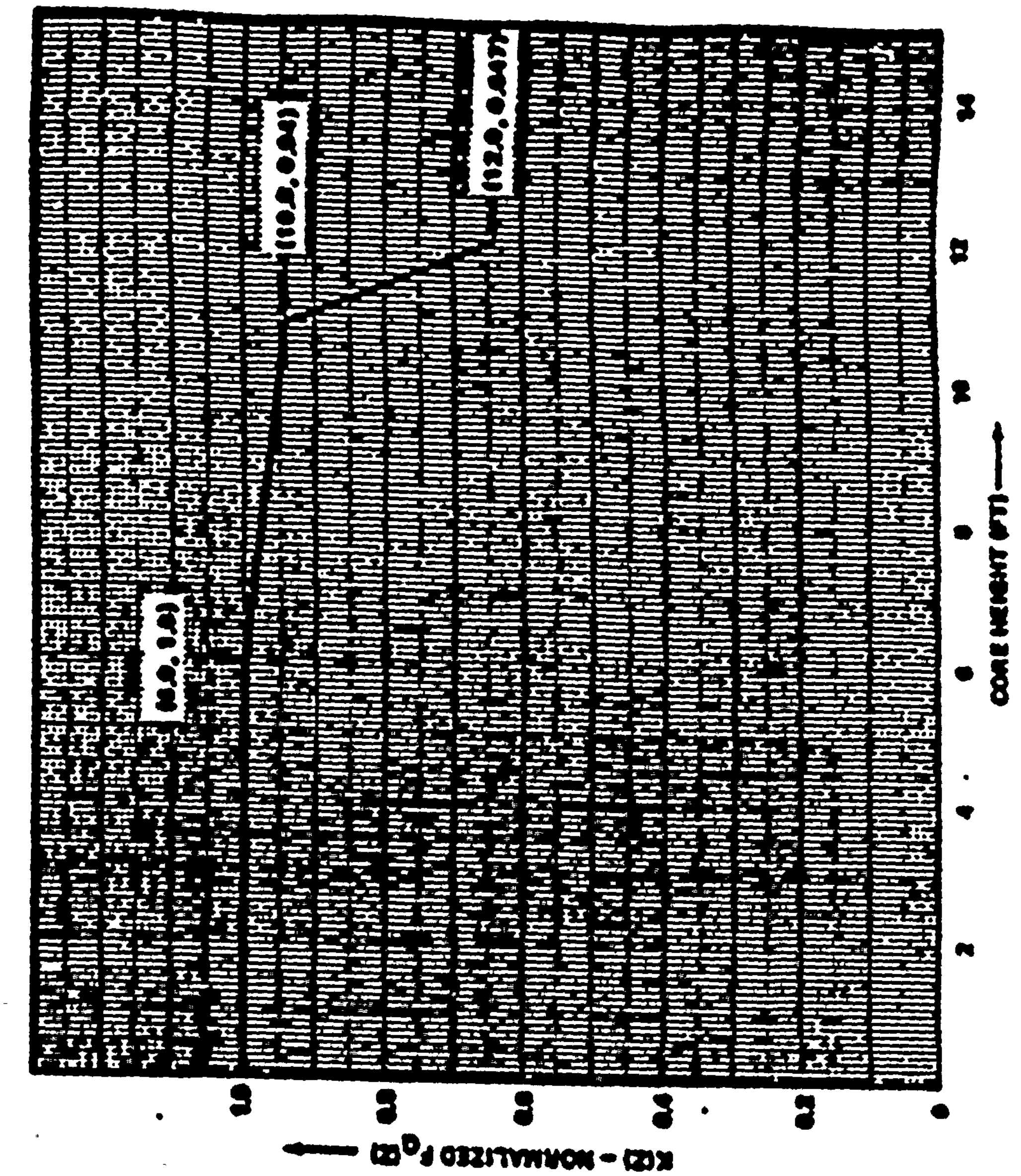



**FIGURE 3.2-2**
**K(Z) Normalized $F_Q(Z)$ as a Function of Core Height**

[illegible]

## 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.

[illegible]

## 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 $F^N_{\Delta H}$ 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 $F^N_{\Delta H}$ and $F_Q(Z)$