LIMITING CONDITIONS FOR OPERATION AND SURVEILLANCE REQUIREMENTS

LIMITING CONDITION FOR OPERATION (Continued)

a) 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.

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

Measurement

Core

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) The THERMAL POWER level is reduced to less than or equal to 75% of RATED THERMAL POWER within the next hour and within the following 4 hours the high neutron flux trip setpoint is reduced to less than or equal to 85% of RATED THERMAL POWER.

SURVEILLANCE REQUIREMENTS

4.1.3.1.1 The position of each full length rod shall be determined to be within the group demand limit by verifying the individual rod positions at least once per 12 hours except during time intervals 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.

LIMITING CONDITION FOR OPERATION (Continued)

a) 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.

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

c) A core power distribution measurement is obtained and $F_Q(z)$ and $F^N_{\Delta H}$ are verified to be within their limits within 72 hours, and

d) The THERMAL POWER level is reduced to less than or equal to 75% of RATED THERMAL POWER within the next hour and within the following 4 hours the high neutron flux trip setpoint is reduced to less than or equal to 85% of RATED THERMAL POWER.

SURVEILLANCE REQUIREMENTS

4.1.3.1.1 The position of each full length rod shall be determined to be within the group demand limit by verifying the individual rod positions at least once per 12 hours except during time intervals 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.

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

### LIMITING CONDITION FOR OPERATION

3.2.2 $F_Q(z)$ shall be limited by the following relationships:

$$F_Q(z) \leq \left[\frac{F_Q^{RTP}}{P}\right] [K(z)] \text{ for } P > 0.5$$

$$F_Q(z) \leq \left[\frac{F_Q^{RTP}}{0.5}\right] [K(z)] \text{ for } P \leq 0.5$$

where $F_Q^{RTP}$ = the $F_Q$ limit at RATED THERMAL POWER (RTP) specified in the CORE OPERATING LIMITS REPORT (COLR),

$P = \dfrac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$, and

$K(z)$ = the normalized $F_Q(z)$ for a given core height specified in the COLR.

APPLICABILITY: MODE 1.

ACTION.

With $F_Q(Z)$ exceeding its limit:

a. Reduce THERMAL POWER at least 1% for each 1% $F_Q(z)$ exceeds the limit 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 have been reduced at least 1% for each 1% $F_Q(z)$ exceeds the limit.

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

Core power distribution measurement

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

### LIMITING CONDITION FOR OPERATION

3.2.2 $F_Q(z)$ shall be limited by the following relationships:

$$F_Q(z) \leq \frac{\left[F_Q^{RTP}\right]}{P} \left[K(z)\right] \text{ for } P > 0.5$$

$$F_Q(z) \leq \left[\frac{F_Q^{RTP}}{0.5}\right] \left[K(z)\right] \text{ for } P \leq 0.5$$

where $F_Q^{RTP}$ = the $F_Q$ limit at RATED THERMAL POWER (RTP) specified in the CORE OPERATING LIMITS REPORT (COLR),

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

$K(z)$ = the normalized $F_Q(z)$ for a given core height specified in the COLR.

APPLICABILITY: MODE 1.

ACTION:

With $F_Q(z)$ exceeding its limit:

a. Reduce THERMAL POWER at least 1% for each 1% $F_Q(z)$ exceeds the limit 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 have been reduced at least 1% for each 1% $F_Q(z)$ exceeds the limit.

b. Identify and correct the cause of the out of limit condition prior to increasing THERMAL POWER above the reduced limit required by a, above; THERMAL POWER may then be increased provided $F_Q(z)$ is demonstrated through core power distribution measurement to be within its limit.

1. WHEN THERMAL POWER is ≤ 25%, but > 5% of RATED THERMAL POWER, or
2. When the Power Distribution Monitoring System (PDMS) is inoperable;
And increasing the Measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

## SURVEILLANCE REQUIREMENTS

4.2.2.1 The provisions of Specification 4.0.4 are not applicable.

4.2.2.2 For RAOC operation, $F_Q(z)$ shall be evaluated to determine if $F_Q(z)$ is within its limit by:

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

USING the PDMS When THERMAL POWER is > 25% of RATED THERMAL POWER and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement Uncertainties as specified in the COLR.

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. Verify the requirements of Specification 3.2.2 are satisfied.~~

c. Satisfying the following relationship:

$$F_Q^M(z) \leq \frac{F_Q^{RTP} \times K(z)}{P \times W(z)} \text{ for } P > 0.5$$

$$F_Q^M(z) \leq \frac{F_Q^{RTP} \times K(z)}{W(z) \times 0.5} \text{ for } P \leq 0.5$$

as specified in the COLR

where $F_Q^M(z)$ is the measured $F_Q(z)$ increased by the applicable allowances for manufacturing tolerances and measurement uncertainty, $F_Q^{RTP}$ is the $F_Q$ limit, K(z) is the normalized $F_Q(z)$ as a function of core height, P is the relative THERMAL POWER, and W(z) is the cycle dependent function that accounts for power distribution transients encountered during normal operation. $F_Q^{RTP}$, K(z) and W(z) are specified in the CORE OPERATING LIMITS REPORT as per Specification 6.9.1.11.

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

1. Upon achieving equilibrium conditions after exceeding by 10% or more of RATED THERMAL POWER, the THERMAL POWER at which $F_Q(z)$ was last determined, * or

2. At least once per 31 Effective Full Power Days, whichever occurs first.

*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 the Core power distribution ~~map~~ Measurement is obtained.

SURVEILLANCE REQUIREMENTS

4.2.2.1 The provisions of Specification 4.0.4 are not applicable.

4.2.2.2 For RAOC operation, $F_Q(z)$ shall be evaluated to determine if $F_Q(z)$ is within its limit by:

a. Using the movable incore detectors to obtain a power distribution map

1. When THERMAL POWER is ≤ 25%, but > 5% of RATED THERMAL POWER, or

2. When the Power Distribution Monitoring System (PDMS) is inoperable;

and increasing the Measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

b. Using the PDMS when THERMAL POWER is > 25% of RATED THERMAL POWER, and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

c. Satisfying the following relationship:

$$F_Q^M(z) \le \frac{F_Q^{RTP} \times K(z)}{P \times W(z)} \text{ for } P > 0.5$$

$$F_Q^M(z) \le \frac{F_Q^{RTP} \times K(z)}{W(z) \times 0.5} \text{ for } P \le 0.5$$

where $F_Q^M(z)$ is the measured $F_Q(z)$ increased by the applicable allowances for manufacturing tolerances and measurement uncertainty as specified in the COLR, $F_Q^{RTP}$ is the $F_Q$ limit, K(z) is the normalized $F_Q(z)$ as a function of core height, P is the relative THERMAL POWER, and W(z) is the cycle dependent function that accounts for power distribution transients encountered during normal operation. $F_Q^{RTP}$, K(z) and W(z) are specified in the CORE OPERATING LIMITS REPORT as per Specification 6.9.1.11.

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

1. Upon achieving equilibrium conditions after exceeding by 10% or more of RATED THERMAL POWER, the THERMAL POWER at which $F_Q(z)$ was last determined, * or

2. At least once per 31 Effective Full Power Days, whichever occurs first.

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* 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 the core power distribution measurement is obtained.

SURVEILLANCE REQUIREMENTS (Continued)

e. With the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

over the core height (z) increasing since the previous determination of $F_Q^M(z)$ either of the following actions shall be taken:

(1) $F_Q^M(z)$ shall be increased by 2% over that specified in Specification 4.2.2.2c. or

(2) $F_Q^M(z)$ shall be measured at least once per 7 Effective Full Power Days until two successive ~~maps~~ Power distribution measurements indicate that the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

over the core height (z) is not increasing.

f. With the relationships specified in Specification 4.2.2.2c. above not being satisfied:

(1) Calculate the maximum percent over the core height (z) that $F_Q(z)$ exceeds its limit by the following expression:

$$\left\{\left[\frac{\frac{F_Q^M(z) \times W(z)}{RTP}}{\frac{F_Q}{P} \times K(z)}\right] - 1\right\} \times 100 \text{ for } P \geq 0.5$$

$$\left\{\left[\frac{\frac{F_Q^M(z) \times W(z)}{RTP}}{\frac{F_Q}{0.5} \times K(z)}\right] - 1\right\} \times 100 \text{ for } P < 0.5$$

e. With the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

over the core height (z) increasing since the previous determination of $F_Q^M(z)$ either of the following actions shall be taken:

(1) $F_Q^M(z)$ shall be increased by 2% over that specified in Specification 4.2.2.2c. or

(2) $F_Q^M(z)$ shall be measured at least once per 7 Effective Full Power Days until two successive power distribution measurements indicate that the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

over the core height (z) is not increasing.

f. With the relationships specified in Specification 4.2.2.2c. above not being satisfied:

(1) Calculate the maximum percent over the core height (z) that $F_Q(z)$ exceeds its limit by the following expression:

$$\left\{\left[\frac{F_Q^M(z) \times W(z)}{\frac{F_Q^{RTP}}{P} \times K(z)}\right] - 1\right\} \times 100 \text{ for } P \geq 0.5$$

$$\left\{\left[\frac{F_Q^M(z) \times W(z)}{\frac{F_Q^{RTP}}{0.5} \times K(z)}\right] - 1\right\} \times 100 \text{ for } P < 0.5$$

(2) One of the following actions shall be taken:

(a) Within 15 minutes, control the AFD to within new AFD limits which are determined by reducing the applicable AFD limits by 1% AFD for each percent $F_Q(z)$ exceeds its limits as determined in Specification 4.2.2.2f.1). Within 8 hours, reset the AFD alarm setpoints to these modified limits, or

(b) Comply with the requirements of Specification 3.2.2 for $F_Q(z)$ exceeding its limit by the percent calculated above, or

(c) Verify that the requirements of Specification 4.2.2.3 for Base Load operation are satisfied and enter Base Load operation.

g. The limits specified in Specifications 4.2.2.2c., 4.2.2.2e., and 4.2.2.2f. above are not applicable in the following core plane regions:

1. Lower core region from 0 to 15%, inclusive.
2. Upper core region from 85 to 100%, inclusive.

4.2.2.3 Base Load operation is permitted at powers above $APL^{ND}$ if the following conditions are satisfied:

a. Prior to entering Base Load operation, maintain THERMAL POWER above $APL^{ND}$ and less than or equal to that allowed by Specification 4.2.2.2 for at least the previous 24 hours. Maintain Base Load operation surveillance (AFD within applicable target band about the target flux difference) during this time period. Base Load operation is then permitted providing THERMAL POWER is maintained between $APL^{ND}$ and $APL^{BL}$ or between $APL^{ND}$ and 100% (whichever is most limiting) and $F_Q$ surveillance is maintained pursuant to Specification 4.2.2.4. $APL^{BL}$ is defined as the minimum value of:

$$APL^{BL} = \frac{F_Q^{RTP} \times K(z)}{F_Q^M(z) \times W(z)_{BL}} \times 100\%$$

applicable

as specified in the COLR

over the core height (z) where: $F_Q^M(z)$ is the measured $F_Q(z)$ increased by the allowances for manufacturing tolerances and measurement uncertainty. The $F_Q$ limit is $F_Q^{RTP}$. $W(z)_{BL}$ is the cycle dependent function that accounts for limited power distribution transient encountered during base load operation. $F_Q^{RTP}$, K(z), and $W(z)_{BL}$ are specified in the CORE OPERATING LIMITS REPORT as per Specification 6.9.1.11.

SURVEILLANCE REQUIREMENTS (Continued)

(2) One of the following actions shall be taken:

(a) Within 15 minutes, control the AFD to within new AFD limits which are determined by reducing the applicable AFD limits by 1% AFD for each percent $F_Q(z)$exceeds its limits as determined in Specification 4.2.2.2f.1). Within 8 hours, reset the AFD alarm setpoints to these modified limits, or

(b) Comply with the requirements of Specification 3.2.2 for $F_Q(z)$ exceeding its limit by the percent calculated above, or

(c) Verify that the requirements of Specification 4.2.2.3 for Base Load operation are satisfied and enter Base Load operation.

g. The limits specified in Specifications 4.2.2.2c., 4.2.2.2e., and 4.2.2.2f. above are not applicable in the following core plane regions:

1. Lower core region from 0 to 15%, inclusive.
2. Upper core region from 85 to 100%, inclusive.

4.2.2.3 Base Load operation is permitted at powers above $APL^{ND}$ if the following conditions are satisfied:

a. Prior to entering Base Load operation, maintain THERMAL POWER above $APL^{ND}$ and less than or equal to that allowed by Specification 4.2.2.2 for at least the previous 24 hours. Maintain Base Load operation surveillance (AFD within applicable target band about the target flux difference) during this time period. Base Load operation is then permitted providing THERMAL POWER is maintained between $APL^{ND}$ and $APL^{BL}$ or between $APL^{ND}$ and 100% (whichever is most limiting) and $F_Q$ surveillance is maintained pursuant to Specification 4.2.2.4. $APL^{BL}$ is defined as the minimum value of:

$$APL^{BL} = \frac{F_Q^{RTP} \times K(z)}{F_Q^M(z) \times W(z)_{BL}} \times 100\%$$

over the core height (z) where: $F_Q^M(z)$ is the measured $F_Q(z)$ increased by the applicable allowances for manufacturing tolerances and measurement uncertainty as specified in the COLR. The $F_Q$ limit is $F_Q^{RTP}$. $W(z)_{BL}$ is the cycle dependent function that accounts for limited power distribution transient encountered during base load operation. $F_Q^{RTP}$, K(z), and $W(z)_{BL}$ are specified in the CORE OPERATING LIMITS REPORT as per Specification 6.9.1.11.

When the Power Distribution Monitoring System (PDMS) is inoperable; and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR

SURVEILLANCE REQUIREMENTS (Continued)

b. During Base Load operation, if the THERMAL POWER is decreased below $APL^{ND}$ then the conditions of 4.2.2.3.a shall be satisfied before re-entering Base Load operation.

4.2.2.4 During Base Load Operation $F_Q(z)$ shall be evaluated to determine if $F_Q(z)$ is within its limit by:

a. Using the movable incore detectors to obtain a power distribution map at any THERMAL POWER above ~~$APL^{ND}$.~~

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. Verify the requirements of Specification 3.2.2 are satisfied.~~

using the PDMS at any THERMAL POWER greater than $APL^{ND}$; and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR

c. Satisfying the following relationship:

$$F_Q^M(z) \le \frac{F_Q^{RTP} \times K(z)}{P \times W(z)_{BL}} \text{ for } P > APL^{ND}$$

increased by the applicable allowances for manufacturing and measurement uncertainties as specified in the COLR

where: $F_Q^M(z)$ is the measured $F_Q(z)$. The $F_Q$ limit is $F_Q^{RTP}$.

P is the relative THERMAL POWER. $W(z)_{BL}$ is the cycle dependent function that accounts for limited power distribution transients encountered during normal operation. $F_Q^{RTP}$, $K(z)$ and $W(z)_{BL}$ are specified in the CORE OPERATING LIMITS REPORT as per Specification 6.9.1.11.

d. Measuring $F_Q^M(z)$ in conjunction with target flux difference determination according to the following schedule:

1. Prior to entering BASE LOAD operation after satisfying Section 4.2.2.3 unless a ~~full core flux map has been taken~~ core power distribution measurement has been obtained in the previous 31 EFPD with the relative thermal power having been maintained above $APL^{ND}$ for the 24 hours prior to ~~mapping~~ measurement, and

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

e. With the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

SURVEILLANCE REQUIREMENTS (Continued)

b. During Base Load operation, if the THERMAL POWER is decreased below $APL^{ND}$ then the conditions of 4.2.2.3.a shall be satisfied before re-entering Base Load operation.

4.2.2.4 During Base Load Operation $F_Q(z)$ shall be evaluated to determine if $F_Q(z)$ is within its limit by:

a. Using the movable incore detectors to obtain a power distribution map at any THERMAL POWER above $APL^{ND}$ when the Power Distribution Monitoring System (PDMS) is inoperable; and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

b. Using the PDMS at any THERMAL POWER greater than $APL^{ND}$; and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

c. Satisfying the following relationship:

$$F_Q^M(z) \leq \frac{F_Q^{RTP} \times K(z)}{P \times W(z)_{BL}} \quad \text{for } P > APL^{ND}$$

where: $F_Q^M(z)$ is the measured $F_Q(z)$ increased by the applicable allowances for manufacturing and measurement uncertainties as specified in the COLR. The $F_Q$ limit is $F_Q^{RTP}$. P is the relative THERMAL POWER. $W(z)_{BL}$ is the cycle dependent function that accounts for limited power distribution transients encountered during normal operation. $F_Q^{RTP}$, K(z) and $W(z)_{BL}$ are specified in the CORE OPERATING LIMITS REPORT as per Specification 6.9.1.11.

d. Measuring $F_Q^M(z)$ in conjunction with target flux difference determination according to the following schedule:

1. Prior to entering BASE LOAD operation after satisfying Section 4.2.2.3 unless a core power distribution measurement has been obtained in the previous 31 EFPD with the relative thermal power having been maintained above $APL^{ND}$ for the 24 hours prior to measurement, and

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

e. With the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

1. when THERMAL POWER is ≤ 25%, but > 5% of RATED THERMAL POWER, or
2. when the Power Distribution Monitoring System (PDMS) is inoperable;

and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR

over the core height (z) increasing since the previous determination of $F_Q^M(z)$ either of the following actions shall be taken:

1. $F_Q^M(z)$ shall be increased by 2 percent over that specified in 4.2.2.4.c, or

2. $F_Q^M(z)$ shall be measured at least once per 7 Effective Full Power Days until 2 successive ~~maps~~ power distribution measurements indicate that the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

over the core height (z) is not increasing.

f. With the relationship specified in 4.2.2.4.c above not being satisfied, either of the following actions shall be taken:

1. Place core in an equilibrium condition where the limit in 4.2.2.2.c is satisfied, and remeasure $F_Q^M(z)$, or

2. Comply with the requirements of Specification 3.2.2 for $F_Q(z)$ exceeding its limit by the maximum percent calculated over the core height (z) with the following expression:

$$\left\{\left[\frac{F_Q^M(z) \times W(z)_{BL}}{\frac{F_Q^{RTP}}{P} \times K(z)}\right] - 1\right\} \times 100 \text{ for } P \geq APL^{ND}$$

g. The limits specified in 4.2.2.4.c, 4.2.2.4.e, and 4.2.2.4.f above are not applicable in the following core plane regions:

1. Lower core region 0 to 15 percent, inclusive.

2. Upper core region 85 to 100 percent, inclusive.

4.2.2.5 When $F_Q(z)$ is measured for reasons other than meeting the requirements of Specification 4.2.2.2 an overall measured $F_Q(z)$ shall be obtained: a. from a power distribution map ~~and increased by 3% to account for manufacturing tolerances and further increased by 5% to account for measurement uncertainty~~.

b. from the PDMS when THERMAL POWER is > 25% of RATED THERMAL POWER; and increasing the measured by the applicable manufacturing and measurement uncertainties as specified in the COLR.

over the core height (z) increasing since the previous determination of $F_Q^M(z)$ either of the following actions shall be taken:

1. $F_Q^M(z)$ shall be increased by 2 percent over that specified in 4.2.2.4.c, or

2. $F_Q^M(z)$ shall be measured at least once per 7 Effective Full Power Days until 2 successive power distribution measurements indicate that the maximum value of

$$\frac{F_Q^M(z)}{K(z)}$$

over the core height (z) is not increasing.

f. With the relationship specified in 4.2.2.4.c above not being satisfied, either of the following actions shall be taken:

1. Place core in an equilibrium condition where the limit in 4.2.2.2.c is satisfied, and remeasure $F_Q^M(z)$, or

2. Comply with the requirements of Specification 3.2.2 for $F_Q(z)$ exceeding its limit by the maximum percent calculated over the core height (z) with the following expression:

$$\left\{\left[\frac{F_Q^M(z) \times W(z)_{BL}}{\frac{F_Q^{RTP}}{P} \times K(z)}\right] - 1\right\} \times 100 \text{ for } P \geq APL^{ND}$$

g. The limits specified in 4.2.2.4.c, 4.2.2.4.e, and 4.2.2.4.f above are not applicable in the following core plane regions:

1. Lower core region 0 to 15 percent, inclusive.

2. Upper core region 85 to 100 percent, inclusive.

4.2.2.5 When $F_Q(z)$ is measured for reasons other than meeting the requirements of Specification 4.2.2.2 an overall measured $F_Q(z)$ shall be obtained:

a. from a power distribution map

1. when THERMAL POWER is ≤ 25%, but > 5% of RATED THERMAL POWER, or

2. when the Power Distribution Monitoring System (PDMS) is inoperable;

and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

b. from the PDMS when THERMAL POWER is > 25% of RATED THERMAL POWER; and increasing the measured $F_Q(z)$ by the applicable manufacturing and measurement uncertainties as specified in the COLR.

POWER DISTRIBUTION LIMITS

3/4.2.3 RCS FLOW RATE AND NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR

LIMITING CONDITION FOR OPERATION

3.2.3 The combination of indicated Reactor Coolant System (RCS) total flow rate and R shall be maintained within the region of allowable operation as specified in the CORE OPERATING LIMITS REPORT (COLR) figure entitled RCS Total Flow Rate Versus R For Three Loop Operation.

Where:

a. $R = \dfrac{F^{N}_{\Delta H}}{F^{RTP}_{\Delta H}[1.0 + PF_{\Delta H}(1.0 - P)]}$,

b. $P = \dfrac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$,

c. $F^{N}_{\Delta H}$ = Measured values of $F^{N}_{\Delta H}$ obtained by: 1. ~~using the movable incore detectors to obtain a power distribution map~~ when THERMAL POWER is ≤25%, but >5% of RATED THERMAL POWER, or when PDMS is inoperable, and 2. Using the PDMS when THERMAL POWER is >25% of RATED THERMAL POWER. The measured values of $F^{N}_{\Delta H}$ shall be increased by the applicable $F^{N}_{\Delta H}$ measurement uncertainties as specified in the COLR, and used to calculate R since the RCS Total Flow Rate Versus R figure in the COLR includes measurement uncertainties of 2.1% (includes 0.1% for feedwater venturi fouling) for flow ~~and 4% for incore measurement of $F^{N}_{\Delta H}$, and~~ ,

d. $F^{RTP}_{\Delta H}$ = The $F^{N}_{\Delta H}$ limit at RATED THERMAL POWER specified in the COLR~~.~~, and

e. $PF_{\Delta H}$ = The Power Factor Multiplier specified in the COLR.

APPLICABILITY: MODE 1.

ACTION:

With the combination of RCS total flow rate and R outside the region of acceptable operation specified in the COLR:

a. Within 2 hours either:

1. Restore the combination of RCS total flow rate and R to within the above limits, or

2. 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~~ a core power distribution measurement and RCS total flow rate comparison that the combination of R and RCS total flow rate are restored to within the above limits, or reduce THERMAL POWER to less than 5% of RATED THERMAL POWER within the next 2 hours.

## 3/4.2.3 RCS FLOW RATE AND NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR

### LIMITING CONDITION FOR OPERATION

3.2.3 The combination of indicated Reactor Coolant System (RCS) total flow rate and R shall be maintained within the region of allowable operation as specified in the CORE OPERATING LIMITS REPORTS (COLR) figure entitled RCS Total Flow Rate Versus R For Three Loop Operation.

Where:

a. $R = \dfrac{F^{N}_{\Delta H}}{F^{RTP}_{\Delta H}\left[1.0 + PF_{\Delta H}(1.0 - P)\right]}$,

b. $P = \dfrac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$,

c. $F^{N}_{\Delta H}$ = Measured values of $F^{N}_{\Delta H}$ obtained by

1. Using the movable incore detectors to obtain a power distribution map when THERMAL POWER is ≤ 25% but > 5% of RATED THERMAL POWER, or when PDMS is inoperable, and

2. Using the PDMS when THERMAL POWER is > 25% of RATED THERMAL POWER.

The measured values of $F^{N}_{\Delta H}$ shall be increased by the applicable $F^{N}_{\Delta H}$ measurement uncertainties as specified in the COLR, and used to calculate R since the RCS Total Flow Rate Versus R figure in the COLR includes measurement uncertainties of 2.1% (includes 0.1% for feedwater venturi fouling) for flow,

d. $F^{RTP}_{\Delta H}$ = The $F^{N}_{\Delta H}$ limit at RATED THERMAL POWER specified in the COLR, and

e. $PF_{\Delta H}$ = The Power Factor Multiplier specified in the COLR.

APPLICABILITY: MODE 1.

ACTION:

With the combination of RCS total flow rate and R outside the region of acceptable operation specified in the COLR:

a. Within 2 hours either:

1. Restore the combination of RCS total flow rate and R to within the above limits, or

2. 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 a core power distribution measurement and RCS total flow rate comparison that the combination of R and RCS total flow rate are restored to within the above limits, or reduce THERMAL POWER to less than 5% of RATED THERMAL POWER within the next 2 hours.

## LIMITING CONDITION FOR OPERATION

ACTION: (Continued)

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 items a.2. and/or b. above; subsequent POWER OPERATION may proceed provided that the combination of R and indicated RCS total flow rate are demonstrated, through ~~incore flux mapping~~ a core power distribution measurement and RCS total flow rate comparison, to be within the region of acceptable operation specified in the COLR 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 The combination of indicated RCS total flow rate and R shall be determined to be within the region of acceptable operation specified in the COLR.

a. Prior to operation 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 indicated RCS total flow rate shall be verified to be within the region of acceptable operation specified in the COLR at least once per 12 hours when the most recently obtained value of R, obtained per Specification 4.2.3.2, is assumed to exist.

4.2.3.4 The RCS total flow rate indicators shall be subjected to a CHANNEL CALIBRATION at least once per 18 months.

4.2.3.5 The RCS total flow rate shall be determined by heat balance measurement at ≥90% RATED THERMAL POWER at least once per 18 months.

## LIMITING CONDITION FOR OPERATION

ACTION: (Continued)

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 items a.2. and/or b. above; subsequent POWER OPERATION may proceed provided that the combination of R and indicated RCS total flow rate are demonstrated, through a core power distribution measurement and RCS total flow rate comparison, to be within the region of acceptable operation specified in the COLR 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 The combination of indicated RCS total flow rate and R shall be determined to be within the region of acceptable operation specified in the COLR.

a. Prior to operation 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 indicated RCS total flow rate shall be verified to be within the region of acceptable operation specified in the COLR at least once per 12 hours when the most recently obtained value of R, obtained per Specification 4.2.3.2, is assumed to exist.

4.2.3.4 The RCS total flow rate indicators shall be subjected to a CHANNEL CALIBRATION at least once per 18 months.

4.2.3.5 The RCS total flow rate shall be determined by heat balance measurement at ≥90% RATED THERMAL POWER at least once per 18 months.

Limiting Condition For Operation

ACTION: (Continued)

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

3. Identify and correct the cause of the out of limit condition prior to increasing THERMAL POWER; subsequent POWER OPERATION above 50% of RATED THERMAL POWER may proceed provided that the QUADRANT POWER TILT RATIO is verified within its limit at least once per hour for 12 hours or until verified at 95% or greater RATED THERMAL POWER.

d. The provisions of Specification 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.2.4.1 The QUADRANT POWER TILT RATIO shall be determined to be within the limit above 50% of RATED THERMAL POWER by:

a. Calculating the ratio at least once per 7 days when the alarm is OPERABLE.

b. Calculating the ratio at least once per 12 hours during steady state operation when the alarm is inoperable.

4.2.4.2 The QUADRANT POWER TILT RATIO shall be determined to be within the limit when above 75 percent of RATED THERMAL POWER with one Power Range Channel inoperable by using the movable incore detectors to confirm that the normalized symmetric power distribution, obtained from 2 sets of 4 symmetric thimble locations or a ~~full~~ ~~core flux map~~, is consistent with the indicated QUADRANT POWER TILT RATIO at least once per 12 hours.

core power distribution measurement

LIMITING CONDITION FOR OPERATION

ACTION: (Continued)

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

3. Identify and correct the cause of the out of limit condition prior to increasing THERMAL POWER; subsequent POWER OPERATION above 50% of RATED THERMAL POWER may proceed provided that the QUADRANT POWER TILT RATIO is verified within its limit at least once per hour for 12 hours or until verified at 95% or greater RATED THERMAL POWER.

d. The provisions of Specification 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.2.4.1 The QUADRANT POWER TILT RATIO shall be determined to be within the limit above 50% of RATED THERMAL POWER by:

a. Calculating the ratio at least once per 7 days when the alarm is OPERABLE.

b. Calculating the ratio at least once per 12 hours during steady state operation when the alarm is inoperable.

4.2.4.2 The QUADRANT POWER TILT RATIO shall be determined to be within the limit when above 75 percent of RATED THERMAL POWER with one Power Range Channel inoperable by using the movable incore detectors to confirm that the normalized symmetric power distribution, obtained from 2 sets of 4 symmetric thimble locations or a core power distribution measurement, is consistent with the indicated QUADRANT POWER TILT RATIO at least once per 12 hours.

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% of the detector thimbles,

b. A minimum of 2 detector thimbles per core quadrant, and

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

APPLICABILITY: When the movable incore detection system is used for:

a. Recalibration of the excore neutron flux detection system,

b. Monitoring the QUADRANT POWER TILT RATIO using a full-core flux map per Specification 4.2.4.2, or

c. Measurement of $F^N_{\Delta H}$, $F_Q(Z)$, ~~and $F_{xy}$~~

and

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 $F^N_{\Delta H}$, $F_Q(Z)$, ~~and $F_{xy}$~~.

and

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% of the detector thimbles,

b. A minimum of 2 detector thimbles per core quadrant, and

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

APPLICABILITY: When the movable incore detection system is used for:

a. Recalibration of the excore neutron flux detection system,

b. Monitoring the QUADRANT POWER TILT RATIO using a full-core flux map per Specification 4.2.4.2, 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 $F_Q(z)$.

INSTRUMENTATION

~~MONITORING INFORMATION~~

POWER DISTRIBUTION MONITORING SYSTEM

LIMITING CONDITION FOR OPERATION

3.3.3.~~8~~ -11 The POWER DISTRIBUTION MONITORING SYSTEM (PDMS) shall be OPERABLE with:

a. A minimum of the following inputs from the plant ~~shall be~~ available for use by the PDMS as defined in Table 3.3.3.~~12~~ 14.

1. Control Bank Position

2. $T_{cold}$

3. Reactor Power Level

4. NIS Power Range Detector Section Signals

b. Core Exit Thermocouples (T/C) meeting the Criteria:

1. At least 25% operable T/C with at least 2 T/C per quadrant, and

2. The T/C pattern has coverage of all interior fuel assemblies (no face along the baffle), within a chess~~board's~~ knights move, radially, from a responding, calibrated T/C, or OR

3. At least 25% operable T/C with at least 2 T/C per quadrant, and the installed PDMS calibration was determined within the last 31 Effective Full Power Days (EFPD).

4. The T/C temperatures used by the PDMS are calibrated via cross calibration with the loop temperature measurement RTDs, and using the T/C flow mixing factors determined during installed PDMS calibration.

c. An installed PDMS calibration satisfying the criteria:

1. The initial calibration in each operating cycle is determined using measurements from at least 75% of the incore movable detector thimbles obtained at a THERMAL POWER greater than ~~or equal to~~ 25% of RATED THERMAL POWER.

2. The calibration is determined using measurements from at least 50% of the incore movable detector thimbles at any time except as specified in 3.3.3.~~12~~ 11.c.1. and

3. The calibration is determined using a minimum of 2 detector thimbles per core quadrant.

APPLICABILITY: MODE 1, ABOVE 25% RATED THERMAL POWER ~~above 25% RATED THERMAL POWER~~

ACTION:

With any of the operability criteria listed in 3.3.3.~~12~~ 11.a, 3.3.3.~~12~~ 11.b, or 3.3.3.~~12~~ 11.c not met, either correct the deficient operability condition, or declare the PDMS INOPERABLE and use the incore movable detector system, satisfying the OPERABILITY requirements listed in specification 3.3.3.2, to obtain any required core power distribution measurements. Increase the measured core peaking factors using the values listed in the COLR for the PDMS INOPERABLE condition.

THE Provisions of specifications 3.0.3 and 3.0.4 are not Applicable

## SURVEILLANCE REQUIREMENTS

4.3.3.~~12~~11.1 The operability criteria listed in 3.3.3.~~12~~11.a, 3.3.3.~~12~~11.b and 3.3.3.~~12~~11.c, shall be verified to be satisfied prior to acceptance of the PDMS core power distribution measurement results.

4.3.3.~~12~~11.2 Calibration of the PDMS is required:

a. at least once every 180 Effective Full Power Days when the minimum number and core coverage criteria as defined in 3.3.3.~~12~~11.b.1, and 3.3.3.~~12~~11.b.2 are satisfied, or

b. at least once every 31 Effective Full Power days when only the minimum number criterion as defined in 3.3.3.~~12~~11.b.3 is satisfied.

LIMITING CONDITION FOR OPERATION

3.3.3.11 The Power Distribution Monitoring System (PDMS) shall be OPERABLE with:

a. A minimum of the following inputs from the plant available for use by the PDMS as defined in Table 3.3-14.

   1. Control Bank Position

   2. $T_{cold}$

   3. Reactor Power Level

   4. NIS Power Range Detector Section Signals

b. Core Exit Thermocouples (T/C) meeting the criteria:

   1. At least 25% operable T/C with at least 2 T/C per quadrant, and

   2. The T/C pattern has coverage of all interior fuel assemblies (no face along the baffle), within a chess knight's move, radially, from a responding, calibrated T/C, or

   3. At least 25% operable T/C with at least 2 T/C per quadrant, and the installed PDMS calibration was determined within the last 31 Effective Full Power Days (EFPD).

   4. The T/C temperatures used by the PDMS are calibrated via cross calibration with the loop temperature measurement RTDs, and using the T/C flow mixing factors determined during installed PDMS calibration.

c. An installed PDMS calibration satisfying the criteria:

   1. The initial calibration in each operating cycle is determined using measurements from at least 75% of the incore movable detector thimbles obtained at a THERMAL POWER greater than 25% of RATED THERMAL POWER.

   2. The calibration is determined using measurements from at least 50% of the incore movable detector thimbles at any time except as specified in 3.3.3.11.c.1, and

   3. The calibration is determined using a minimum of 2 detector thimbles per core quadrant.

## LIMITING CONDITION FOR OPERATION (Continued)

APPLICABILITY: MODE 1, above 25% RATED THERMAL POWER (RTP)

ACTION:

With any of the operability criteria listed in 3.3.3.11.a, 3.3.3.11.b, or 3.3.3.11.c not met, either correct the deficient operability condition, or declare the PDMS inoperable and use the incore movable detector system, satisfying the OPERABILITY requirements listed in Specification 3.3.3.2, to obtain any required core power distribution measurements. Increase the measured core peaking factors using the values listed in the COLR for the PDMS inoperable condition.

The provisions of Specifications 3.0.3 and 3.0.4 are not applicable.

## SURVEILLANCE REQUIREMENTS

4.3.3.11.1 The operability criteria listed in 3.3.3.11.a, 3.3.3.11.b, and 3.3.3.11.c shall be verified to be satisfied prior to acceptance of the PDMS core power distribution measurement results.

4.3.3.11.2 Calibration of the PDMS is required:

a. at least once every 180 Effective Full Power Days when the minimum number and core coverage criteria as defined in 3.3.3.11.b.1 and 3.3.3.11.b.2 are satisfied, or

b. at least once every 31 Effective Full Power Days when only the minimum number criterion as defined in 3.3.3.11.b.3 is satisfied.

TABLE 3.3.3-~~15~~ 14

REQUIRED PDMS PLANT INPUT INFORMATION

| PLANT INPUT INFORMATION | AVAILABLE INPUTS | MINIMUM NO. OF VALID INPUTS | APPLICABLE MODES |
|---|---|---|---|
| 1. Control Bank Position | 4 | 4[a] | 1[c] |
| 2. $T_{cold}$ | 3 | 2 | 1[c] |
| 3. Reactor Power Level | 3 | 1[b] | 1[c] |
| 4. NIS Power Range Excore Detector Section Signals | 8 | 6[d] | 1[c] |

TABLE NOTATIONS

a. Determined from either valid Demand Position or the average of the valid individual RCCA position indications for all RCCAs in the Control Bank.

b. Determined from either the reactor thermal power derived using a valid secondary calorimetric measurement, the average NIS Power Range Detector Power, or the average RCS Loop ΔT.

c. Greater than ~~or equal to~~ 25% RTP

d. ~~The total number of valid input must be comprised of corresponding upper and lower detector section signals in each available Power Range Detector Channel.~~
Comprised of an upper and a lower ~~det to~~ detector section signal per Power Range Channel; a minimum of 3 ~~operable~~ OPERABLE Channels required.

TABLE 3.3-14

REQUIRED PDMS PLANT INPUT INFORMATION

| | PLANT INPUT INFORMATION | AVAILABLE INPUTS | MINIMUM NO. OF VALID INPUTS | APPLICABLE MODES |
|---|---|---|---|---|
| 1. | Control Bank Position | 4 | 4[a] | 1[c] |
| 2. | $T_{cold}$ | 3 | 2 | 1[c] |
| 3. | Reactor Power Level | 3 | 1[b] | 1[c] |
| 4. | NIS Power Range Excore Detector Section Signals | 8 | 6[d] | 1[c] |

TABLE NOTATIONS

a. Determined from either valid Demand Position or the average of the valid individual RCCA position indications for all RCCAs in the Control Bank.

b. Determined from either the reactor THERMAL POWER derived using a valid secondary calorimetric measurement, the average NIS Power Range Detector Power, or the average RCS Loop $\Delta T$.

c. Greater than 25% RTP.

d. Comprised of an upper and lower detector section signal per Power Range Channel; a minimum of 3 OPERABLE channels required.

HEAT FLUX HOT CHANNEL FACTOR and RCS FLOWRATE and NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR (Continued)

← INSERT 1

The hot channel factor $F_Q^M(z)$ is measured periodically and increased by a cycle and height dependent power factor appropriate to either RAOC or Base Load operation, $W(z)$ or $W(z)_{BL}$, to provide assurance that the limit on the hot channel factor, $F_Q(z)$ is met. $W(z)$ accounts for the effects of normal operation transients and was determined from expected power control maneuvers over the full range of burnup conditions in the core. $W(z)_{BL}$ accounts for the more restrictive operating limits allowed by Base Load operation which result in less severe transient values. The $W(z)$ and $W(z)_{BL}$ functions described above for normal operation are specified in the CORE OPERATING LIMITS REPORT (COLR) per Specification 6.9.1.11.

← INSERT 2

~~When RCS flow rate and $F_{\Delta H}$ are measured, no additional allowances are necessary prior to comparison with the limits of the RCS Total Flow Rate Versus R figure in the COLR. Measurement errors of 2.1% for RCS total flow rate including 0.1% for feedwater venturi fouling and 4% for $F_{\Delta H}$ have been allowed for in determining the limits of the RCS Total Flow Rate Versus R figure in the COLR.~~

The 12-hour periodic surveillance of indicated RCS flow is sufficient to detect only flow degradation which could lead to operation outside the acceptable region of operation specified on the RCS Total Flow Rate Versus R figure in the COLR.

3/4.2.4 QUADRANT POWER TILT RATIO

The quadrant power tilt ratio limit assures that the radial power distribution satisfies the design values used in the power capability analysis. Radial power distribution measurements are made during startup testing and periodically during power operation.

The limit of 1.02, at which corrective action is required, provides DNB and linear heat generation rate protection with x-y plane power tilts. A limiting tilt of 1.025 can be tolerated before the margin for uncertainty in $F_Q$ is depleted. The limit of 1.02 was selected to provide an allowance for the uncertainty associated with the indicated power tilt.

The two hour time allowance for operation with a tilt condition greater than 1.02 but less than 1.09 is provided to allow identification and correction of a dropped or misaligned control rod. In the event such action does not correct the tilt, the margin for uncertainty on $F_Q$ is reinstated by reducing the maximum allowed power by 3 percent for each percent of tilt in excess of 1.0.

For purposes of monitoring QUADRANT POWER TILT RATIO when one excore detector is inoperable the movable incore detectors are used to confirm that the normalized symmetric power distribution is consistent with the QUADRANT POWER TILT RATIO. The incore detector monitoring is done with a full incore flux map or two sets of 4 symmetric thimbles. These locations are C-8, E-5, E-11, H-3, H-13, L-5, L-11, N-8.

or a ~~full~~ Core power distribution measurement

Insert 1

For measurements obtained using the Power Distribution Monitoring System (PDMS), the appropriate measurement uncertainty is determined using the measurement uncertainty methodology contained in WCAP 12472-P-A. The cycle and plant uncertainty calculation information needed to support the PDMS calculation is contained in the COLR. The PDMS will automatically calculate and apply the correct measurement uncertainty, and apply a 3% allowance for manufacturing tolerance.

Insert 2

When RCS flow rate is measured, no additional allowances are necessary prior to comparison with the limits of the RCS Total Flow Rate Versus R Figure in the COLR. Measurement errors of 2.1% for RCS total flow rate, including 0.1% for feedwater venturi fouling, have been allowed for in determining the RCS Total Flow Rate Versus R Figure in the COLR.

For $F^N_{\Delta H}$ measurements obtained from a full core flux map taken with the incore detector flux mapping system, a 4% measurement uncertainty allowance should be applied to the measured $F^N_{\Delta H}$ value prior to comparison with the limits of the RCS Total Flow Rate Versus R Figure in the COLR. The appropriate measurement uncertainty for $F^N_{\Delta H}$ measurements obtained using the Power Distribution Monitoring System (PDMS) is determined using the uncertainty methodology described in WCAP 12472-P-A. The cycle and plant specific uncertainty calculation information needed to support the PDMS uncertainty calculation is contained in the COLR. The PDMS will automatically calculate and apply the correct measurement uncertainty to the measured $F^N_{\Delta H}$.

HEAT FLUX HOT CHANNEL FACTOR and RCS FLOWRATE and NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR (Continued)

For measurements obtained using the Power Distribution Monitoring System (PDMS), the appropriate measurement uncertainty is determined using the measurement uncertainty methodology contained in WCAP-12472-P-A. The cycle and plant specific uncertainty calculation information needed to support the PDMS calculation is contained in the COLR. The PDMS will automatically calculate and apply the correct measurement uncertainty, and apply a 3% allowance for manufacturing tolerance.

The hot channel factor $F_Q^M(z)$ is measured periodically and increased by a cycle and height dependent power factor appropriate to either RAOC or Base Load operation, W(z) or $W(z)_{BL}$, to provide assurance that the limit on the hot channel factor, $F_Q(z)$ is met. W(z) accounts for the effects of normal operation transients and was determined from expected power control maneuvers over the full range of burnup conditions in the core. $W(z)_{BL}$ accounts for the more restrictive operating limits allowed by Base Load operation which result in less severe transient values. The W(z) and $W(z)_{BL}$ functions described above for normal operation are specified in the CORE OPERATING LIMITS REPORT (COLR) per Specification 6.9.1.11.

When RCS flow rate is measured, no additional allowances are necessary prior to comparison with the limits of the RCS Total Rate Versus R figure in the COLR. Measurement errors of 2.1% for RCS total flow rate, including 0.1% for feedwater venturi fouling, have been allowed for in determining the RCS Total Flow Rate Versus R Figure in the COLR.

For $F_{\Delta H}^N$ measurements obtained from a full core flux map taken with the incore detector flux mapping system, a 4% measurement uncertainty allowance should be applied to the measured $F_{\Delta H}^N$ value prior to comparison with the limits of the RCS Total Flow Rate Versus R Figure in the COLR. The appropriate measurement uncertainty for $F_{\Delta H}^N$ measurements obtained using the Power Distribution Monitoring System (PDMS) is determined using the uncertainty methodology described in WCAP-12472-P-A. The cycle and plant specific uncertainty calculation information needed to support the PDMS uncertainty calculation is contained in the COLR. The PDMS will automatically calculate and apply the correct measurement uncertainty to the measured $F_{\Delta H}^N$ value.

The 12-hour periodic surveillance of indicated RCS flow is sufficient to detect only flow degradation which would lead to operation outside the acceptable region of operation specified on the RCS Total Flow Rate Versus R figure in the COLR.

3/4.2.4 QUADRANT POWER TILT RATIO

The quadrant power tilt power ratio limit assures that the radial power distribution satisfies the design values used in the power capability analysis. Radial power distribution measurements are made during startup testing and periodically during power operation.

QUADRANT POWER TILT RATIO
~~HEAT FLUX HOT CHANNEL FACTOR and RCS FLOWRATE and NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR~~ (Continued)

## 3/4.2.5 DNB PARAMETERS

The limits on the DNB related parameters assure that each of the parameters are maintained within the normal steady state envelope of operation assumed in the transient and accident analyses. The limits are consistent with the initial FSAR assumptions and have been analytically demonstrated adequate to maintain a minimum DNBR in the core at or above the design limit throughout each analyzed transient. The maximum indicated Tavg limit of 589.2°F and the minimum indicated pressure limit of 2206 psig correspond to analytical limits of 591.4°F and 2185 psig respectively, read from control board indications.

The 12-hour periodic surveillance of these parameters through instrument readout is sufficient to ensure that the parameters are restored within their limits following load changes and other expected transient operation.

QUADRANT POWER TILT RATIO (Continued)

The limit of 1.02, at which corrective action is required, provides DNB and linear heat generation rate protection with x-y plane power tilts. A limiting tilt of 1.025 can be tolerated before the margin for uncertainty in $F_Q$ is depleted. The limit of 1.02 was selected to provide an allowance for the uncertainty associated with the indicated power tilt.

The two hour time allowance for operation with a tilt condition greater than 1.02 but less than 1.09 is provided to allow identification and correction of a dropped or misaligned control rod. In the event such action does not correct the tilt, the margin for uncertainty on $F_Q$ is reinstated by reducing the maximum allowed power by 3 percent for each percent of tilt in excess of 1.0.

For purposes of monitoring QUADRANT POWER TILT RATIO when one excore detector is inoperable, the movable incore detectors or a core power distribution measurement are used to confirm that the normalized symmetric power distribution is consistent with the QUADRANT POWER TILT RATIO. The incore detector monitoring is done with a full incore flux map or two sets of 4 symmetric thimbles. These locations are C-8, E-5, E-11, H-3, H-13, L-5, L-11, N-8.

3/4.2.5 DNB PARAMETERS

The limits on the DNB related parameters assure that each of the parameters are maintained within the normal steady state envelope of operation assumed in the transient and accident analyses. The limits are consistent with the initial FSAR assumptions and have been analytically demonstrated adequate to maintain a minimum of DNBR in the core at or above the design limit throughout each analyzed transient. The maximum indicated $T_{avg}$ limit of 589.2°F and the minimum indicated pressure limit of 2206 psig correspond to analytical limits of 591.4°F and 2185 psig respectively, read from control board indications.

The 12-hour periodic surveillance of these parameters through instrument readout is sufficient to ensure that the parameters are restored within their limits following load changes and other expected transient operation.

3/4.3.3.9 EXPLOSIVE GAS MONITORING INSTRUMENTATION

This instrumentation includes provisions for monitoring and controlling the concentrations of potentially explosive gas mixtures in the waste gas holdup system. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

3/4.3.3.10 LOOSE-PART DETECTION INSTRUMENTATION

The OPERABILITY of the loose-part detection instrumentation ensures that sufficient capability is available to detect loose metallic parts in the primary system and avoid or mitigate damage to primary system components. The allowable out-of-service times and surveillance requirements are consistent with the recommendations of Regulatory Guide 1.133, "Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors," May 1981.

New
↓

3/4.3.3.~~12~~ 11 POWER DISTRIBUTION MONITORING SYSTEM (PDMS)

The Power Distribution Monitoring System (PDMS) provides core monitoring of the limiting parameters. The PDMS continuous core power distribution measurement methodology begins with the periodic generation of a highly accurate 3-D nodal simulation of the current reactor power distribution. The simulated reactor power distribution is then continuously adjusted by nodal and thermocouple calibration factors derived from an incore power distribution measurement obtained using the incore movable detectors to produce a highly accurate power distribution measurement. The nodal calibration factors are updated at least once every 180 Effective Full Power Days (EFPD). Between calibrations, the fidelity of the measured power distribution is maintained via adjustment to the calibrated power distribution provided by continuously input plant and core condition information. The plant and core condition data utilized by the PDMS is cross checked using redundant information to provide a robust basis for continued operation. The loop inlet temperature is generated by averaging the respective temperatures from each of the loops, excluding any bad data. The core exit thermocouples provide many readings across the core and by the nature of their usage with the PDMS, smoothing of the measured data and elimination of bad data is performed with the Surface Spline fit. The PDMS uses the NIS Power Range excore detectors to provide information on the axial power distribution. Hence, the PDMS averages the data from the four Power Range excore detectors and eliminates any bad excore detector data.

## 3/4.3.3.9 EXPLOSIVE GAS MONITORING INSTRUMENTATION

This instrumentation includes provisions for monitoring and controlling the concentrations of potentially explosive gas mixtures in the waste gas holdup system. The OPERABILITY and use of this instrumentation is consistent with the requirements of General Design Criteria 60, 63 and 64 of Appendix A to 10 CFR Part 50.

## 3/4.3.3.10 LOOSE-PART DETECTION INSTRUMENTATION

The OPERABILITY of the loose-part detection instrumentation ensures that sufficient capability is available to detect loose metallic parts in the primary system and avoid or mitigate damage to primary system components. The allowable out-of-service times and surveillance requirements are consistent with the recommendations of Regulatory Guide 1.133, "Loose-Part Detection Program for the Primary System of Light-Water-Cooled Reactors," May 1981.

## 3/4.3.3.11 POWER DISTRIBUTION MONITORING SYSTEM (PDMS)

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The bases for the operability requirements of the PDMS is to provide assurance of the accuracy and reliability of the core parameters measured and calculated by the PDMS core power distribution monitor function. These requirements fall under four categories:

1. Assure an adequate number of operable critical sensors.
2. Assure sufficiently accurate calibration of these sensors.
3. Assure an adequate calibration data base regarding the number of data sets.
4. Assure the overall accuracy of the calibration.

POWER DISTRIBUTION MONITORING SYSTEM (continued)

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1. Assure an adequate number of operable critical sensors.

2. Assure sufficiently accurate calibration of these sensors.

3. Assure an adequate calibration data base regarding the number of data sets.

4. Assure the overall accuracy of the calibration.

The minimum number of required plant and core condition inputs includes the following:

1. Control Bank Positions.

2. At least 50% of the cold leg temperatures.

3. At least 75% of the signals from the Power Range excore detector channels (comprised of a top and bottom detector section).

4. Reactor Power Level.

5. A minimum number and distribution of operable core exit thermocouples.

6. A minimum number and distribution of measured fuel assembly power distribution information obtained using the incore movable detectors is incorporated in the nodal model calibration information.

The sensor calibration of items 1., 2., 3., and 4. above are covered under other specifications. Calibration of the core exit thermocouples is accomplished in two parts. The first being a sensor specific correction to K-type thermocouple temperature indications based on data from a cross calibration of the thermocouple temperature indications to the average RCS temperature measured via the RTDs under isothermal RCS conditions. The second part of the thermocouple calibration is the generation of thermocouple flow mixing factors which cause the radial power distribution measured via the thermocouples to agree with the radial power distribution from a full core flux map measured using the incore movable detectors. This calibration is updated at least once every 180 EFPD.

POWER DISTRIBUTION MONITORING SYSTEM (PDMS) (Continued)

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6.9.1.9 Not used.

## MONTHLY OPERATING REPORT

6.9.1.10 Routine reports of operating statistics and shutdown experience, including documentation of all challenges to the PORV's or safety valves, shall be submitted on a monthly basis to the Director, Office of Resource Management, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, with a copy to the Regional Office of Inspection and Enforcement, no later than the 15th of each month following the calendar month covered by the report.

A report of any major changes to the radioactive waste treatment systems shall be submitted with the Monthly Operating Report for the period in which the evaluation was reviewed and accepted as set forth in 6.5 above. *

## CORE OPERATING LIMITS REPORT

6.9.1.11 Core operating limits shall be established and documented in the CORE OPERATING LIMITS REPORT prior to each reload cycle, or prior to any remaining portion of a reload cycle, for the following:

a. Moderator Temperature Coefficient BOL and EOL Limits and 300 ppm surveillance limit for Specification 3/4.1.1.3,

b. Shutdown Rod Insertion Limit for Specification 3/4.1.3.5,

c. Control Rod Insertion Limits for Specification 3/4.1.3.6,

d. Axial Flux Difference Limits, target band, and APLND for Specification 3/4.2.1,

e. Heat Flux Hot Channel Factor, $F_Q^{RTP}$, K(Z), W(Z), $APL^{ND}$, ~~and~~ W(Z)BL, , and $F_Q(Z)$ manufacturing/measurement uncertainties for Specification 3/4.2.2, |

f. Nuclear Enthalpy Rise Hot Channel Factor, $F_{\Delta H}^{RTP}$, ~~and~~ Power Factor Multiplier, $PF_{\Delta H}$, and $F_{\Delta H}^N$ measurement uncertainties limits for Specification 3/4.2.3. |

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

a. WCAP-9272-P-A, "WESTINGHOUSE RELOAD SAFETY EVALUATION METHODOLOGY," July 1985 (W Proprietary).

6.9.1.9 Not used.

MONTHLY OPERATING REPORT

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c. Control Rod Insertion Limits for Specification 3/4.1.3.6,

d. Axial Flux Difference Limits, target band, and $APL^{ND}$ for Specification 3/4.2.1,

e. Heat Flux Hot Channel Factor, $F_Q^{RTP}$, K(z), W(z), $APL^{ND}$, $W(z)_{BL}$, and $F_Q(z)$ manufacturing/measurement uncertainties for Specification 3/4.2.2,

f. Nuclear Enthalpy Rise Hot Channel Factor, $F_{\Delta H}^{RTP}$, Power Factor Multiplier, $PF_{\Delta H}$, and $F_{\Delta H}^{N}$ measurement uncertainties limits for Specification 3/4.2.3.

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

a. WCAP-9272-P-A, "WESTINGHOUSE RELOAD SAFETY EVALUATION METHODOLOGY," July 1985 (W Proprietary).

CORE OPERATING LIMITS REPORT (Continued)

(Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown ~~Bank~~ ROD Insertion Limit, 3.1.3.6 - Control ~~Bank~~ ROD Insertion Limit, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor).

b. WCAP-10216-P-A, Rev. 1A, "RELAXATION OF CONSTANT AXIAL OFFSET CONTROL FQ SURVEILLANCE TECHNICAL SPECIFICATION", February 1994 (W Proprietary).

(Methodology for Specifications 3.2.1 - Axial Flux Difference (Relaxed Axial Offset Control) and 3.2.2 - Heat Flux Hot Channel Factor (FQ Methodology for W(Z) surveillance requirement).)

c. WCAP-10266-P-A, Rev. 2, "THE 1981 VERSION OF WESTINGHOUSE EVALUATION MODEL USING BASH CODE", March 1987; Including Addendum 2-A, "BASH METHODOLOGY IMPROVEMENTS AND RELIABILITY ENHANCEMENTS," ~~MAY~~ May 1988, (W Proprietary).

(Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor).

The core operating limits shall be determined so that all applicable limits (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, nuclear limits such as shutdown margin, and transient and accident analysis limits) of the safety analysis are met.

The CORE OPERATING LIMITS REPORT, including any mid-cycle revisions or supplements there to shall be provided upon issuance, for each reload cycle, to the NRC Document Control Desk with copies to the Regional Administrator and Resident Inspector.

d. WCAP-12472-P-A, "BEACON Core Monitoring and Operations Support System," August 1994, (W Proprietary).

(Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor, 3.2.3 - RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor, and 3.2.4 - Quadrant Power Tilt Ratio).

CORE OPERATING LIMITS REPORT (Continued)

(Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Rod Insertion Limit, 3.1.3.6 - Control Rod Insertion Limit, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor.)

b. WCAP-10216-P-A, Rev. 1A, "RELAXATION OF CONSTANT AXIAL OFFSET CONTROL $F_Q$ SURVEILLANCE TECHNICAL SPECIFICATION", February 1994 (W Proprietary).

(Methodology for Specifications 3.2.1 - Axial Flux Difference (Relaxed Axial Offset Control) and 3.2.2 - Heat Flux Hot Channel Factor ($F_Q$ Methodology for W(z) surveillance requirements)).

c. WCAP-10266-P-A, Rev. 2, "THE 1981 VERSION OF WESTINGHOUSE EVALUATION MODEL USING BASH CODE", March 1987; Including Addendum 2-A, "BASH METHODOLOGY IMPROVEMENTS AND RELIABILITY ENHANCEMENTS", May 1988, (W Proprietary).

(Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor).

d. WCAP-12472-P-A, "BEACON CORE MONITORING AND OPERATIONS SUPPORT SYSTEM", August 1994, (W Proprietary).

(Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor, 3.2.3 - RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor, and 3.2.4 - Quadrant Power Tilt Ratio).

The core operating limits shall be determined so that all applicable limits (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, nuclear limits such as shutdown margin, and transient and accident analysis limits) of the safety analysis are met.

The CORE OPERATING LIMITS REPORT, including any mid-cycle revisions or supplements there to shall be provided upon issuance, for each reload cycle, to the NRC Document Control Desk with copies to the Regional Administrator and Resident Inspector.

# SAFETY EVALUATION
# FOR REVISING THE TECHNICAL SPECIFICATIONS
# TO INCORPORATE BEACON
# IN THE VIRGIL C. SUMMER NUCLEAR STATION
# TECHNICAL SPECIFICATIONS

## Description of Amendment Request

The Virgil C. Summer Nuclear Station (VCSNS) Technical Specifications (TS) are being revised to incorporate a Power Distribution Monitoring System (PDMS). This system utilizes a NRC approved Westinghouse Proprietary Computer System, the Best Estimate Analyzer for Core Operations - Nuclear (BEACON), to augment the functionality of the flux mapping system for purposes of power distribution surveillances. The proposed Technical Specification Changes allow the use of the PDMS to perform core power distribution surveillances. However, the PDMS is only used when Thermal Power is greater than 25% RTP. At Thermal Powers less than or equal to 25% RTP or when the PDMS is inoperable, the movable incore detector system will be used. The existing Technical Specifications require the surveillances to be performed using the movable incore detector system.

The affected Technical Specifications are:

| | | |
|---|---|---|
| (a) | 3/4.1.3 | Movable Control Assemblies - Group Height |
| (b) | 3/4.2.2 | Heat Flux Hot Channel Factor |
| (c) | 3/4.2.3 | RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor |
| (d) | 3/4.2.4 | Quadrant Power Tilt Ratio |
| (e) | 3/4.3.3.11 | Power Distribution Monitoring System |
| (f) | 6.9.1.11 | Core Operating Limits Report |

In addition, one section is added to the Core Operating Limits Report (COLR). This section defines the equations and constants used to determine the applicable measurement uncertainties applied to the core peaking factors when determined by either the PDMS or the flux mapping system. The constants found in this section of the COLR are used as coefficients in the uncertainty calculations and are determined using NRC-approved methodology. The constants may be revised periodically as appropriate to reflect cycle-specific variables.

The NRC approved WCAP-12472-P-A (Topical Report for BEACON) on February 16, 1994. The NRC concludes that BEACON provides a greatly improved continuous on-line power distribution measurement and display, limit surveillance, and operation prediction information system for Westinghouse reactors.

Virgil C. Summer Nuclear Station is proposing to implement BEACON to augment the functionality of the flux mapping system for purposes of power distribution surveillances. The Technical Specification changes discussed in WCAP-12472-P-A are applicable to an application of BEACON in which the core power distribution limits are changed and BEACON is monitored continuously by plant operators. For the application of BEACON to Virgil C. Summer, the premise is that BEACON will be used for power distribution measurement instead of the flux mapping system when Thermal Power is greater than 25% RTP. All power distribution limits remain unchanged. Thus, the VCSNS use of the BEACON system is a more restrictive application than is approved in the WCAP.

In this application, if the PDMS meets specified operability requirements (i.e., operability of incore detectors, core exit thermocouples, and excore detectors), it is used to determine the measured core peaking factors. The power distribution surveillance continues to be performed with the same periodicity (once every 31 EFPD under normal circumstances, although more frequent surveillances may be required under certain circumstances).

## Safety Evaluation

The use of BEACON as a power Distribution Monitoring System has no impact upon plant operation or safety. No safety-related equipment, safety function, or plant operations will be altered as a result of this proposed change. Since the applicable FSAR limits will be maintained and the Technical Specifications will continue to require operation within the core operational limits calculated by these NRC-approved methodologies, this proposed change is administrative in nature. Appropriate actions to be taken if limits are violated also remain unchanged in the Technical Specifications.

This proposed change will control the cycle-specific parameters within the acceptance criteria and assure conformance to 10 CFR 50.36 by using the approved methodology instead of specifying Technical Specifications values. The COLR will document the specific parameter limits resulting from VCSNS calculations, including mid-cycle or other revisions to parameter values. Therefore, the proposed change is in conformance with the requirements of 10 CFR 50.36.

Any changes to the COLR will be made in accordance with the provisions of 10 CFR 50.59. From cycle to cycle, the COLR will be revised such that the appropriate core operating limits for the applicable cycle will apply. The facility Technical Specifications will not require future changes associated with core parameters.

The following is a summary/excerpt of BNLs Technical Evaluation Report (TER) for WCAP-12472-P-A. The section numbers and titles are those specified in the TER.

*BNLs Technical Evaluation Report (TER):*

*2.1 BEACON On-line Core Monitoring Methodology:*
*2.1.1 Determination of the Core Power Distribution:*

The primary function of the BEACON core monitoring system is the determination of the three-dimensional core power distribution. In BEACON, this calculation is performed with the NRC approved Westinghouse SPNOVA nodal method. The SPNOVA data libraries and core models are consistent with the NRC approved Westinghouse PHOENIX/ANC design models and have been extensively benchmarked against operating reactor measurements.

*2.1.2 Calibration of the Core Power Distribution:*

BEACON uses the incore flux detector measurements, core-exit thermocouples and excore detectors to perform the local calibration of the SPNOVA three-dimensional power distribution. The SPNOVA predicted detector reaction rates are normalized to the incore measurements at the incore radial locations and over an axial mesh. The thermocouple adjustment is two-dimensional and is made by normalizing the SPNOVA radial power distribution to the assembly power inferred from the core-exit thermocouples. The thermocouple assembly power measurement is periodically calibrated to the incore-measured assembly power.

The incore detectors and core-exit thermocouples do not provide complete coverage of the core and BEACON employs a two-dimensional spline fit to interpolate/extrapolate these measurements to the unmonitored assemblies. The spline fit includes a tolerance factor which controls the degree to which the fit is forced to match the individual measurements. If, for example, the measurements are believed to be extremely accurate (inaccurate) a low (high) tolerance factor is used and the SPNOVA solution is (not) forced to be in exact agreement with the measurements.

The BEACON axial power shape is adjusted to insure agreement with the axial offset measured by the excore detectors. This adjustment is made by adding a sinusoidal component to the SPNOVA calculated axial power shape. The SPNOVA excore axial offset is determined by an appropriate weighting of the peripheral assembly powers. The excore detector axial offset is periodically calibrated to the incore detector measurement.

*2.1.3 BEACON Core Monitoring Methodology:*

The BEACON core monitoring process is carried out in three steps. In the first step the SPNOVA model, individual thermocouples, and the excore axial offset are calibrated to the full-core incore flux measurement. In the second step, the SPNOVA model is updated based on the most recent operating history, and adjusted using the thermocouple and excore measurements. The continuous monitoring is performed in Step-3 using the thermocouples and excores to update the BEACON model.

The continuous core monitoring of the current reactor statepoint (fuel burnup, xenon distribution, soluble boron concentration, etc.) provided by BEACON allows a more precise determination of the parameters used in the transient analyses, and therefore relaxes the requirement to limit the transient initial conditions via power distribution control. As part of the continuous monitoring, the fuel limits are calculated using the standard Westinghouse methods.

VCSNS BEACON application does not take credit for the continuous monitoring of the power distribution. Therefore, the transient initial conditions limits via power distribution control are not allowed to be relaxed. This results in the peaking factor limits at VCSNS remaining unchanged from the existing limits.

*2.2 Comparison of BEACON and INCORE Power Distributions:*

As an initial assessment of the power distribution calculation, Westinghouse has performed detailed comparisons of BEACON to the predictions of the INCORE System presently used at Westinghouse plants. These comparisons were made for three plants over four cycles, and included a range of fuel burnup, core loadings, power level and control rod insertion. For the high powered assemblies ($P > 1$), BEACON reproduced a set of axially integrated measurements to within a few percent. The BEACON and INCORE axially integrated assembly powers also agreed to within a few percent for a sample of high powered assemblies.

The uncertainties applied to the BEACON power distribution measurements are different than those applied to the traditional flux map systems because BEACON uses a more comprehensive set of instrumentation. An uncertainty analysis of the BEACON power distribution measurement is reported in WCAP-12472 P-A. Since the power distribution measurement methodology is the same between BEACON and the VCSNS application of BEACON, the uncertainty analysis and methodology is applicable to the

VCSNS application of BEACON. Portions of the BNL TER relevant to the uncertainty analysis are excerpted as follows.

> 2.3 *Determination of the BEACON Uncertainty Components:*
> 2.3.1 *Model Calibration:*
>
> Due to the change in reactor statepoint, SPNOVA modeling approximations and instrumentation error, a model calibration uncertainty is introduced into the BEACON predictions. Westinghouse has evaluated this uncertainty by comparing BEACON predicted and measured incore reaction rates over four cycles and a range of operating conditions, and has found that the model calibration uncertainty was very small and varied only slightly for these comparisons.
>
> 2.3.2 *Thermocouple Calibration:*
>
> The thermocouple calibration uncertainty is due to the change in reactor statepoint and to instrument error. Westinghouse has evaluated this uncertainty by comparing the assembly powers inferred from the thermocouples to SPNOVA incore-corrected assembly powers. Comparisons for three plants and a range of operating conditions indicate a difference of less than a few percent at full power. The observed calibration uncertainty increased at lower powers due to the reduced enthalpy rise and changes in cross-flow.
>
> 2.3.3 *Axial Power Distribution Uncertainty:*
>
> In order to determine the axial power distribution uncertainty, Westinghouse has compared SPNOVA incore-updated and SPNOVA excore-updated predictions of the axial power shape. These comparisons included a range of fuel burnups and rod insertions, and indicated a 95/95 upper tolerance limit of less than a few percent with a slight dependence on rod movement since calibration.
>
> 2.3.4 *Calibration Interval:*
>
> Based on an extensive set of calibration data, the model calibration uncertainty is observed to increase as the calibration interval (in units of fuel burnup) increases. Using the observed fuel burnup dependence, an additional assembly power uncertainty is determined to account for the effects of increased calibration interval.

### 2.3.5 *Inoperable Detectors:*

The failure of detectors in the BEACON system results in a relaxation of the local calibration to measurement, and an increase in the power distribution uncertainty. The effect of random failures of the incore and thermocouple detectors on the assembly power was evaluated for failure rates of up to 75%. It is noteworthy that the assembly power uncertainty was found to increase linearly with incore detector failure and quadratically with the failure of thermocouples.

### 2.3.6 *Local Power Distribution Uncertainty:*

The BEACON calculation requires local power distribution factors for: (1) the ratio of assembly power-to-detector response, (2) assembly local peaking factor, and (3) the grid power-depression factor. The BEACON uncertainty analysis employs previously approved upper tolerance values for the assembly power-to-detector response ratio and the local peaking factor. The grid factor uncertainty was determined by comparison to measured flux traces and is found to be relatively small.

### 2.4 *Determination of the BEACON Power Peaking Uncertainty:*

The uncertainty in the BEACON power peaking resulting from errors in the SPNOVA model calibration and thermocouple calibration is determined using an analog Monte Carlo error propagation technique. In this analysis, the BEACON three-step calibration, model update and power distribution update procedure is simulated. The SPNOVA model and thermocouple calibration factors are subjected to random variations (based on their uncertainties) and the resulting variations in the BEACON power distribution are used to determine the 95% probability upper tolerance limit on the assembly power for the twenty highest powered assemblies.

The analysis is performed for a range of operating conditions including off-normal power distributions and extended calibration intervals. A typical set of thermocouple uncertainties is used together with a relatively large tolerance factor which results in substantial smoothing of the thermocouple measurements. The upper tolerance limit on the assembly power peaking factor is calculated and found to increase as the square-root of the thermocouple uncertainty.

The enthalpy-rise ($F_{\Delta H}$) and power peaking factor ($F_Q$) uncertainties are determined by a statistical combination of the assembly peaking factor, axial peaking factor, calibration interval, inoperable detector and local power peaking component uncertainties. The $F_{\Delta H}$ and $F_Q$ uncertainties are calculated for a typical case.

### 3.0 *Summary of the Technical Evaluation:*

The BEACON Core Monitoring and Operations Support System Topical Report WCAP-12472-P provides a detailed description of the BEACON methodology, the uncertainty analysis required to support the proposed Technical Specifications and the operation of the overall system. The review of BEACON focused on the approximations and assumptions implicit in the BEACON methodology, the completeness and accuracy of the BEACON uncertainty analysis and the adequacy of the BEACON core monitoring. Several important technical issues were raised during the initial review which required additional information and clarification from Westinghouse. This information was requested in Reference 6 [Letter from R. C. Jones (NRC) to N. J. Liparulo (Westinghouse), "Request for Additional Information for the Review of the Topical Report WCAP-12472-P, BEACON," August 25, 1992] and was provided in the Westinghouse response included in Reference 7 [Letter from N. J. Liparulo (Westinghouse) to R. C. Jones (NRC), "Responses to NRC Request for Additional Information for WCAP-12472-P (Proprietary)," November 4, 1992]. This evaluation is based on the material presented in the topical report and in Reference 7, and discussions with Westinghouse and the NRC staff at two meetings at the Westinghouse Corporate Offices in Rockville, Maryland on June 9 and September 11, 1992. The evaluation of the major issues raised during this review are summarized in the following.

### 3.1 *BEACON Methodology:*

The BEACON power distribution calculation is updated using the thermocouple and excore detector measurements. The thermocouple measurements are interpolated/extrapolated radially using the spline fit.

The BEACON system provides both a full three-dimensional nodal power distribution calculation as well as a simplified more approximate one-dimensional calculation. The BEACON on-line limits evaluation will be performed in three dimensions and the one-dimensional calculation will only be used as a scoping tool in predictive analysis.

> The accuracy of the BEACON analysis decreases as the calibration intervals increase and the power distribution diverges from the reference power shape. In order to minimize BEACON uncertainty, the reference power distribution is updated every 15 minutes or when significant changes occur in the AFD or the core power.

The majority of the Technical Specification modifications are simply changes which allow the use of the Power Distribution Monitoring System for power distribution limit surveillances. The conditions under which BEACON is determined to be operable were defined during the uncertainty analysis discussed previously and will be incorporated into the facility Technical Specifications. Thus, this ensures that the VCSNS BEACON uncertainties are applicable to the set of instrumentation which BEACON is using. According to the SER:

> The power distribution limits (Technical Specifications 3.2.1 through 3.2.4) remain for the most part unchanged from the current Technical Specifications except that they allow a core power distribution measurement to be obtained through BEACON (when Thermal Power is greater than 25% RTP) without using the incore movable detectors.
>
> The criteria for the incore neutron detectors, with BEACON operable, require at least 75% available at beginning-of-cycle, and a minimum of 50% at any time afterward, with a minimum of two per quadrant. Except for lowering the criterion to 50%, this is the same as in the current STSs. The 50% level is reasonable for BEACON operable because of the increased surveillance available from, for example, the core exit thermocouples. For BEACON inoperable, the minimum requirement remains at 75% and 4 per quadrant, which is acceptable. (This requirement tends to keep the minimum for BEACON operable higher than 50%.)
>
> The criteria for the core exit thermocouples, with BEACON operable, require at least 25% of the thermocouples, with at least 2 per quadrant, with the added requirement that the operable pattern normally covers all internal fuel assemblies within a chess "knight" move (an adjacent plus a diagonal square away), or there must be more frequent calibration. Calibration, with the incores, is required every 180 effective full-power days. However, calibration is required every 30 days when the knight move requirement is not satisfied. The accuracy of the power distribution information with decreased incore or thermocouple detector operability has been analyzed by Westinghouse, and penalties are applied to the calculated peaking factors (refer to TER section 2.3). The review has concluded that the minimum available incore and thermocouple detectors, when coupled with the increased uncertainty penalties, provide reasonable and acceptable power distribution information.

The BEACON system provides the capability for accurate and continuous core monitoring. At VCSNS, BEACON will be used instead of the flux mapping system for power distribution surveillances when Thermal Power is greater than 25% RTP. It uses current plant instrumentation in conjunction with a fully analytical methodology to generate on-line three-dimensional power distributions. The BEACON methodology and the impact of BEACON on Technical Specifications have been accepted by the NRC as documented in WCAP-12472-P-A. The Technical Specifications changes proposed in this submittal are more restrictive than those approved in WCAP-12472-P-A and will not adversely impact the safe operation of VCSNS.

# NO SIGNIFICANT HAZARDS EVALUATION FOR REVISING THE SPECIFICATIONS TO INCORPORATE BEACON IN THE VIRGIL C. SUMMER NUCLEAR STATION TECHNICAL SPECIFICATIONS

## Description of Amendment Request

The Virgil C. Summer Nuclear Station (VCSNS) Technical Specifications (TS) are being revised to incorporate a Power Distribution Monitoring System (PDMS). This system utilizes a NRC approved Westinghouse Proprietary Computer System, the Best Estimate Analyzer for Core Operations - Nuclear (BEACON), to augment the functionality of the flux mapping system for purposes of power distribution surveillances. The proposed Technical Specification Changes allow the use of the PDMS to perform core power distribution surveillances. However, the PDMS is only used when Thermal Power is greater than 25% RTP. At Thermal Powers less than or equal to 25% RTP or when the PDMS is inoperable, the movable incore detector system will be used. The existing Technical Specifications require the surveillances to be performed using the movable incore detector system.

The affected Technical Specifications are:

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| (a) | 3/4.1.3 | Movable Control Assemblies - Group Height |
| (b) | 3/4.2.2 | Heat Flux Hot Channel Factor |
| (c) | 3/4.2.3 | RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor |
| (d) | 3/4.2.4 | Quadrant Power Tilt Ratio |
| (e) | 3/4.3.3.11 | Power Distribution Monitoring System |
| (f) | 6.9.1.11 | Core Operating Limits Report |

In addition, one section is added to the Core Operating Limits Report (COLR). This section defines the equations and constants used to determine the applicable measurement uncertainties applied to the core peaking factors when determined by either the PDMS or the flux mapping system. The constants found in this section of the COLR are used as coefficients in the uncertainty calculations and are determined using NRC-approved methodology. The constants may be revised periodically as appropriate to reflect cycle-specific variables.

The NRC approved WCAP-12472-P-A (Topical Report for BEACON) on February 16, 1994. The NRC concludes that BEACON provides a greatly improved continuous on-line power distribution measurement and display, limit surveillance, and operation prediction information system for Westinghouse reactors.

Virgil C. Summer Nuclear Station is proposing to implement BEACON to augment the functionality of the flux mapping system for purposes of power distribution surveillances. The Technical Specification changes discussed in WCAP-12472-P-A are applicable to an application of BEACON in which the core power distribution limits are changed and BEACON is monitored continuously by plant operators. For the application of BEACON to Virgil C. Summer, the premise is that BEACON will be used for power distribution measurement instead of the flux mapping system when Thermal Power is greater than 25% RTP. All power distribution limits remain unchanged. Thus, the VCSNS use of the BEACON system is a more restrictive application than is approved in the WCAP.

In this application, if the PDMS meets specified operability requirements (i.e., operability of incore detectors, core exit thermocouples, and excore detectors), it is used to determine the measured core peaking factors. The power distribution surveillance continues to be performed with the same periodicity (once every 31 EFPD under normal circumstances, although more frequent surveillances may be required under certain circumstances).

Basis for No Significance Hazards Consideration Determination

South Carolina Electric & Gas Company (SCE&G) has evaluated the proposed changes to the VCSNS TS described above against the Significant Hazards Criteria of 10 CFR 50.92 and has determined that the changes do not involve any significant hazard. The following is provided in support of this conclusion.

1. Does the change involve a significant increase in the probability or consequences of an accident previously evaluated?

   The proposed change allows the Power Distribution Monitoring System (PDMS) to be used for measuring power distribution limits when Thermal Power is greater than 25% RTP. This includes relocating manufacturing and measurement uncertainty values from the Technical Specification to the COLR. Also included in this change is the addition of a new specification and bases section for the Power Distribution Monitoring System (PDMS). The Technical Specification Power Distribution Limits are not being changed; only the method in which they are measured is being changed. The probability of an accident is not significantly increased. The measurement of power distribution limits and the location of manufacturing and measurement uncertainty values are not initiators of any analyzed event. The change will not affect the consequences of any analyzed event. The power distribution limits will still be measured and verified to be within limits as required by the current Technical Specification Surveillance. The cycle-specific core operating limits, although not in Technical

Specifications, will be followed in the operation of VCSNS. The actions as required by current Technical Specifications, when or if limits are exceeded are not being changed. This change will not significantly affect the assumptions relative to the mitigation of accidents.

Each accident analysis addressed in the VCSNS Final Safety Analysis Report will be examined with respect to changes in cycle-dependent parameters, which are obtained from application of the NRC-approved reload design methodologies, to ensure that the transient evaluation of new reloads are bounded by previously accepted analyses. This examination, which will be performed per requirements of 10 CFR 50.59, ensures that future reloads will not involve an increase in the probability or consequences of an accident previously evaluated.

Therefore, the change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the change create the possibility of a new or different kind of accident from any accident previously evaluated?

   The proposed change allows the Power Distribution Monitoring System (PDMS) to be used for measuring power distribution limits when Thermal Power is greater than 25% RTP. This includes relocating manufacturing and measurement uncertainty values from the Technical Specification to the COLR. Also included is the addition of a new specification and bases section for the Power Distribution Monitoring System. No safety-related equipment, safety function, or plant operation will be altered as a result of this proposed change. **No hardware is being added to the plant as part of the change**. The cycle specific variables are calculated using the NRC-approved methods and submitted to the NRC to allow the Staff to continue to trend the values of these limits. The Technical Specifications will continue to require operation within the required core operating limits and appropriate actions will be taken when or if limits are exceeded. The change will not introduce any new accident initiators. Therefore, the change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does this change involve a significant reduction in margin of safety?

   The proposed change allows the Power Distribution Monitoring System (PDMS) to be used for measuring power distribution limits when Thermal Power is greater than 25% RTP. The margin of safety presently provided by current Technical Specifications remains unchanged. Only the method in which the power distribution measurements are obtained is being changed. This method is verified by Westinghouse, and reviewed and approved by the NRC.

Appropriate measures exist to control the values of the manufacturing and measurement uncertainties. The proposed amendment continues to require operation within the core limits, as obtained from NRC-approved reload design methodologies. Appropriate actions required to be taken when or if limits are violated remain unchanged.

Future changes to measurement and manufacturing uncertainties located in the current Technical Specification will be evaluated per the requirements of 10 CFR 50.59. Since the 10 CFR 50.59 process does not allow any reduction in the margin of safety, prior NRC approval is required prior to a reduction in the margin of safety. If the evaluation of the changes do not result in a unreviewed safety question, prior NRC approval will not be required. Additionally, the VCSNS Technical Specifications require that all revisions of the plant COLR be submitted to the NRC upon issuance.

Therefore, the change does not involve a significant reduction in a margin of safety

Pursuant to 10 CFR 50.91, the preceding analyses provides a determination that the proposed Technical Specifications change poses no significant hazard as delineated by 10 CFR 50.92.

Environmental Assessment

This proposed Technical Specification change has been evaluated against criteria for and identification of licensing and regulatory actions requiring environmental assessment in accordance with 10 CFR 51.21. It has been determined that the proposed change meets the criteria for categorical exclusion as provided for under 10 CFR 51.22(c)(9). The following is a discussion of how the proposed Technical Specification change meets the criteria for categorical exclusion.

10 CFR 51.22(c)(9): Although the proposed change involves change to requirements with respect to inspection or Surveillance Requirements,

(i) the proposed change involves No Significance Hazards Consideration (refer to the No Significance Hazards Consideration Determination section of this Technical Specification Change Request);

(ii) there are no significant changes in the types or significant increase in the amounts of any effluents that may be released offsite since the proposed change does not affect the generation of any radioactive effluents nor does it affect any of the permitted release paths; and

(iii) there is no significant increase in individual or cumulative occupational radiation exposure.

Accordingly, the proposed change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Based on the aforementioned and pursuant to 10 CFR 51.22 (b), no environmental assessment or environmental impact statement need be prepared in connection with issuance of an amendment to the Technical Specifications incorporating the proposed change request.